A TREATISE ON HYGIENE.

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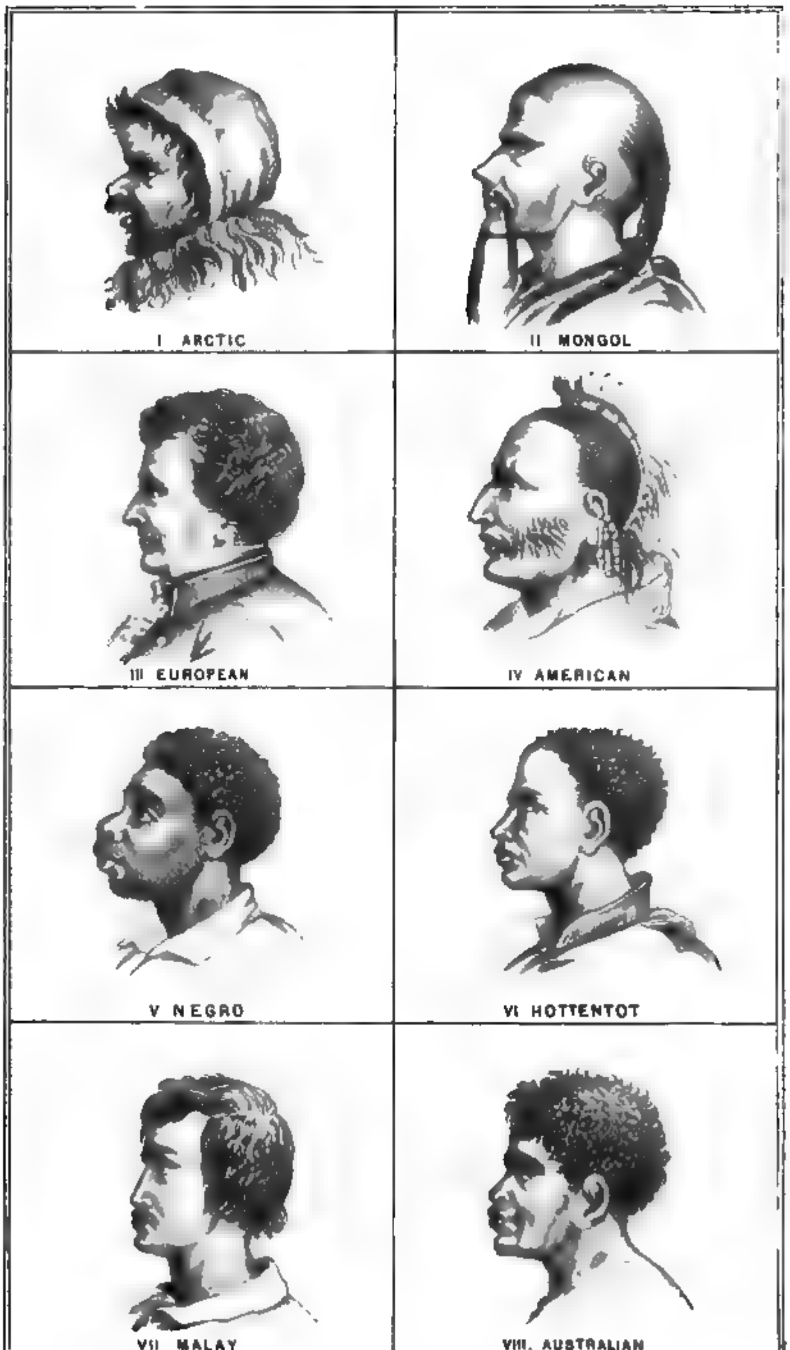
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II MONGOL
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A

TREATISE ON HYGIENE

WITH

SPECIAL REFERENCE

TO

THE MILITARY SERVICE.

BY

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TO

MY FRIEND AND FORMER PRECEPTOR,

WILLIAM H. VAN BUREN, M.D.,

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF NEW YORK,

I Dedicate this Volume,

IN EVIDENCE OF MY REGARD FOR HIM AS A MAN,

MY ESTIMATION OF HIM AS AN ACCOMPLISHED GENTLEMAN AND PHYSICIAN,

AND MY APPRECIATION OF

THE GREAT AND INTELLIGENT INTEREST HE HAS CONSTANTLY TAKEN

IN ALL THAT RELATES TO THE HEALTH AND WELFARE

OF THOSE WHO BELONG TO

THE MILITARY SERVICE OF THEIR COUNTRY.

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PREFACE.

If I had not believed that a great necessity existed for a treatise upon some of the principal subjects of hygiene, I certainly should not, in addition to my onerous public duties, have undertaken the task of preparing the present volume. That a growing attention to the subject of sanitary science is being manifested, cannot be doubted. The most intelligent members of the medical profession recognize the principle that their efforts should be directed more especially to the prevention of disease than to its cure, and the people, who are rarely slow to comprehend matters which it is to their advantage to know, are beginning to appreciate the same fact.

But while I do not wish to be understood as at all doubting the efficacy of proper medication in the treatment of disease, I am sure that the curative influences of hygienic measures have been too much neglected, and that drugs, the traditional actions of which have been positively disproved by physiological and chemical researches, as well as by the soundest deductions from pathology, are too frequently administered through a strict adherence to the routine which hinders the development of medical science, and cramps the powers of those who labor for its advancement. One object therefore which I had in view, was to lay before the profession and those who contemplate entering it some of the principal facts which bear upon the hygienic condition of man in causing, preventing, and curing disease.

But I had a still stronger motive to actuate me. The nation had entered upon a war, for the preservation of its liberties, the most gigantic ever undertaken in the history of the world. Hundreds of thousands, from the boy to the old man, had devoted themselves to the service of their country—men whose value to the State could not be

estimated, and upon whom its future greatness, both in war and peace, in a great measure depended. Thousands of physicians had been found to take the medical charge of the armies created,—many of them well known for their professional eminence, and others, by far the greater number, young and inexperienced, though not lacking the will and the ability to do their whole duty when that duty was pointed out to them. Many of these latter have now become fully equal to the laborious service to which they have devoted themselves, and each month adds efficiency and distinction to the medical corps of the regular and volunteer forces of the army.

In the military service, more than any other, a knowledge of the means of preventing disease and of facilitating recovery by methods other than the mere administration of drugs is necessary. Armies are often so situated that their salvation depends upon the knowledge which the medical officer may possess, and it never happens that some important application of hygienic principles cannot be made to them by those who are charged with their medical superintendence.

But though many excellent treatises upon individual hygiene are to be met with in the French and German languages, there is not one to be found in the English tongue. The little book of Dr. Pickford does not profess to go at any length into the subject, and is devoted almost entirely to the consideration of the meteorological influences exerted upon health, and to the discussion of points of public hygiene; and the excellent treatise of Prof. Dunglison has for many years been out of print. As to military hygiene, I know of no other book on the subject, in the English language, than the capital little manual of Prof. Ordronaux, of Columbia College, which, though containing many most valuable hints in regard to the health of the soldier, was not intended by its accomplished author as a treatise on the subject.

There was no work then to which I could refer those who came to me for information which I had no time to give them as fully as was desirable; and as I had for several years given a large portion of my leisure to the study of hygiene—rather, however, in a desultory way than with any systematic objects in view—I concluded to devote the hours which would otherwise have been passed in rest, in preparing a volume

upon the more important subjects belonging to the science of hygiene, especially those which have a bearing upon the military service.

It is not pretended that this volume is complete. There are several subjects other than those considered, such as Occupation, Exercise, the Excretions, Marriage, Celibacy, etc., which I would have been glad to have taken up, had I not been convinced that the need for some work on sanitary matters was imperative; and therefore, notwithstanding the imperfect result of my labors—the shortcomings of which no one can perceive more clearly than myself—I have concluded to stop for the present, and to defer to a second edition, should such be called for, the more complete fulfilment of my task, by the consideration of topics not only interesting in themselves, but important in their bearings upon the health, the comfort, and the happiness of mankind.

Moreover, I have been restrained from expressing my views fully upon some subjects, for the reason that the immense amount of material which has been collected in the Surgeon-General's office during the past year—an amount unprecedented in the annals of military medicine and surgery, and more even than is contained in the published medical records of all the armies of the world—is not as yet so arranged as to be in a form for satisfactory study, and I therefore preferred, both for my own sake and that of the reader, to delay the consideration of points which otherwise I should have discussed with insufficient light. Besides, much important information might have been given in regard to the relations of medical statistics to hygiene, but for the fact that the associated matter would have been in many instances of value to the enemy in a military point of view.

Since this treatise was commenced, events have been developed with surprising rapidity, and, in consequence, several subjects in regard to which opportunities for forming definite opinions had not been afforded, are now matters of fact. Such, for instance, is that of the adaptability of the negro race for all the purposes of war, which, at the time the chapter on Race was written, was, in some respects, an open question, but which has been recently shown to be no longer a subject of doubt. The opinion then expressed relative to the immunity of this race to attacks of malarious diseases has received additional confirmation from the official re

ports which have recently come to hand, from which it appears that while the white troops are affected to the extent of 10·80 per cent. with diseases of malarious origin, the negro troops serving in the same army show only 0·80 of such diseases.

It is only by yielding our opinions to the necessities of the age in which we live, when every science bearing upon medicine is being developed by the labors of thousands of investigators, that we can claim the right to be regarded as wise physicians seeking only the good of those committed to our charge, rather than our own personal advantage. In science we believe nothing till it is proven, and even then we should be ready to forsake our most cherished doctrines when the evidence of their instability is forthcoming. If, therefore, I have been positive in the expression of opinions which are at variance with those held by others, it is only because I *now* believe them to be correct. To-morrow I may renounce them all.

But even in my positiveness, I hope I have not forgotten the proprieties of life, or the forbearance and courtesy which should prevail in all discussions, especially in those of a scientific character.

WASHINGTON CITY, D. C., *June 25th*, 1863.

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LIST OF ILLUSTRATIONS.

* The work thus designated is the Report of the Commission appointed to inquire into the Sanitary Condition of the Barracks and Hospitals of Great Britain.

A TREATISE ON HYGIENE.

INTRODUCTION.

In order that an army may be effective it must be healthy, and in order that it may be healthy the men composing it must be well formed, of good constitution, free from any disease which can impair their efficiency, and kept, by physical, mental, and dietetic influences, in such a condition as will, if it do not entirely prevent disease, at least reduce the sickness to the lowest possible minimum. The circumstances under which armies are placed, when in the field, are usually such as are directly at variance with hygienic principles. Military necessity, with greater force than any other necessity, knows no law, and should know none; but it is rarely the case that a commander having the good of his troops really at heart, cannot manage to bring into play those sanitary principles which, when properly enforced, add to the comfort, the health, and, consequently, the power of his forces.

To put a soldier into the field costs the government nearly four hundred dollars; should he die, or become permanently disabled in service, a pension is given. Looking at the matter therefore merely in a financial point of view, we perceive that it is a subject of serious importance

that every means should be taken to preserve the lives and health of those who come forward to fight the battles of their country.

Since a knowledge of sanitary science has come to be regarded as an essential part of the education of military medical men, very great progress has been made in lessening the mortality of armies. The Secretary of State for War of the British government, in a recent speech in the House of Commons, said:—

"Improvements have been introduced with a view to ameliorate the social, moral, and sanitary condition of the private soldier. Much expenditure has been incurred for the sake of enlarging and improving barracks, and in carrying out various recommendations of the House of Commons with respect to barracks and the hospitals connected with them. I am happy to say that these efforts have not been unattended with important results, as will appear from authentic returns of the mortality in the service. These returns have been prepared by the Director-General of the Army Medical Department, and I believe they are perfectly authentic, though it is certainly difficult to believe that so great a change can have taken place in so limited a period. It is possible that the greater youth of some portions of the army may, to a certain extent, affect the returns, but I believe the difference is mainly to be explained by improvements in the sanitary conditions under which they are now called on to serve.

"*Deaths among the Troops serving in the United Kingdom annually, per* 1000 *men.*

	From 1830 to 1836.	1859 to 1860.
Generally throughout	14	5
Cavalry of the Line	15	6
Royal Artillery	15	7
Foot Guards	21	9
Infantry of the Line	17	8

"*Similar returns for the Colonies are as follows:—*

	From 1837 to 1856.	1859 to 1861.
Gibraltar	22	9
Malta	18	14
Ionian Islands	27	9
Bermuda	35	11
Canada	20	10
Jamaica	128	17
Ceylon	74	27

"I have other returns, from other colonies," continues the Right Honorable gentleman, "and I believe that these returns are authentic, and certainly they show how very considerable a diminution has taken place in the mortality of the Army, and these results are very encouraging for future attempts in the same line of improvement."*

These results are certainly very striking, but scarcely more than was to be expected, when we consider what vast efforts the British government made to increase the comfort and provide for the health of its soldiers after attention was once directed to the subject. The Crimean war revealed to the British people the fact that their soldiers were scarcely as well cared for as the horses that drew the artillery. Sir John Hall,† Inspector-General of Hospitals, states, in his evidence before the commission appointed to inquire into the sanitary condition of the army, etc., that upon one occasion he made a requisition for a building used as a stable for mules to be turned over to him as a hospital for the sick and wounded soldiers. After considerable correspondence and delay, Sir John announces that the mules "carried the day!"

* On the Growth of the Recruit and Young Soldier, by William Aitken, M.D., Professor of Pathology in the Army Medical School, p. 5.

† Report of the Commissioners on Sanitary Regulations, etc. of British Army. Appendix, p. 104.

On the conclusion of the war, investigations into the character of the existing evils were at once commenced. A commission was appointed to examine all the barracks and hospitals in Great Britain. Action was at once taken on their report. Improvements in the way of light, ventilation, drainage, increased space, etc. were made. Old buildings were entirely remodeled, new hospitals were constructed in which every hygienic point was considered without regard to expense, until now, British soldiers are as well cared for, sick or well, as any other class of men in the world. The results of this enlightened system are seen in the tables adduced by the Secretary of War, which have been already quoted. Is it not our duty to profit by the experience of others, rather than wait to purchase it at our own cost?

The greater number of diseases are, as we shall point out more at length hereafter, more or less preventable. When a preventable disease occurs, some one is to blame—either the subject of it or those who are charged with the duty of providing for his well-being. It may be, and often is the case, in military life, that the responsibility which would otherwise belong to those concerned, is lessened, or even perhaps altogether removed, by the necessities of war; but it should nevertheless be the constant effort of all in authority to expose those under their command as little as possible to morbific influences. The success of well devised measures in this direction has been strikingly manifested in several instances during the present rebellion. General Mitchel, at Hilton Head, and General Butler, at New Orleans, have, by the enforcement of proper hygienic precautions, preserved the troops under their command from yellow fever. In the latter city the exemption has been remarkable, as not a single case of this disease has occurred.

Through the excellent system of ventilation adopted for our military hospitals, and attention to other sanitary measures, hospital gangrene has been entirely prevented in

them, and erysipelas rendered so infrequent that the occurrence of a case excites comment. In European wars both of these diseases have been the curse of hospitals, and doubtless were borne in mind by Sir John Pringle* when he remarked that hospitals were the great cause of mortality in armies.

A large number of the preventable diseases is due to the enlistment of persons who are unfit for service, either from extreme youth, defective development, or the possession of one or more constitutional predispositions to disease. In a great measure these pathological influences can be detected before enlistment, and the service saved the disadvantages which would otherwise result. Moreover, the good of the individual himself should not be disregarded. Many persons of tender age would grow up into healthy adults if not subjected to the hardships of a soldier's life; others, with arrested development of certain parts of the body, would live to an advanced age; and many with strong predispositions to disease would never have this proclivity lighted up but for the privations and labors incident to army service. It thus becomes a matter of primary importance to require the most rigid supervision of those who present themselves for enlistment or who may be drafted into the army, and I shall therefore not hesitate, before proceeding to the systematic consideration of the subject of Hygiene, to point out at length the qualifications which the recruit should possess in order to be accepted, and the disqualifications which should lead to his rejection.

* Observations on Diseases of the Army, Am. edition. Preface, p. xxxiv.

SECTION I.

ON THE EXAMINATION OF RECRUITS.

CHAPTER I.

GENERAL QUALIFICATIONS AND DISQUALIFICATIONS OF RECRUITS.

A WEAK, malformed, or sickly soldier is not only useless, but a positive incumbrance. Not only is he incapable of performing the duty required of him, but his frequent attacks of indisposition demand the services of others in taking care of him, and add very materially to the immobility which, in a greater or less degree, attends all armies. The present rebellion has opened our eyes to the evils flowing from the indiscriminate enrollment of men unfit, by reason of physical infirmities, to undergo the hardships incident to a soldier's life. Thousands of incapacitated men were in the early stages of the war allowed to enter the army, to be discharged after a few weeks' service, most of which had been passed in the hospital. Many did not march five miles before breaking down, and not a few never shouldered a musket during the whole term of their service. In a hospital, under my charge, containing six hundred beds, I discovered at one time, on inspection, fifty-two cases of inguinal hernia in men who had undergone but an insignificant amount of exposure to hardship. Cases of chronic ulcers, varicose veins, epilepsy, and other conditions unfitting men for a military life, came frequently under my notice. The recruits were either not inspected at all by a medical officer, or else the examination was so

loosely conducted as to amount to a farce. I know of several regiments in which the medical inspection was performed by the surgeon walking down the line and looking at the men as they stood in the ranks. Not long since a case was reported to me by an intelligent surgeon, in which the colonel of the regiment to be inspected refused to allow the men to be stripped in order to undergo examination. Matters, however, are better arranged now than at the commencement of the rebellion; but there is every reason to believe that sufficient care is yet by no means taken to prevent the entrance of men into the service who are rather subjects for the hospital than soldiers fit for the field.

In consideration of these facts, it will be well to consider the points which should be insisted upon in passing a recruit, both with the view of protecting the government and the individual. It is better to have no soldiers at all than such as cannot perform the full measure of duty expected of them. This subject has engaged much more attention in Europe than in this country, where, owing to the hitherto small army maintained, it has not been of so great relative importance. Our army is now, however, larger than that of any other nation in the world, and it behooves us to add as much as possible to its efficiency by excluding from it those who, by careful inspection and consideration of their condition, are found to be unfit subjects for enlistment.

Age of the recruit.—According to the United States Army Regulations, recruits must be between the ages of eighteen and thirty-five—exceptions being made only in the cases of musicians, who may be under this minimum, and soldiers re-enlisting, who may be over the maximum.

In the French and Prussian services, twenty years is the minimum age for recruits; in the Austrian, nineteen; and in the British, eighteen, though boys of fourteen are allowed (or were not many years since) to enlist for life.

Perhaps the subject of the age of the recruit is more important than any other. Boys do not make good soldiers, and men considerably over forty years of age not much better. The minimum adopted in this country is, we are satisfied, entirely too low, and even this is by no means adhered to, soldiers (if they are worthy of the name) being met with—generally in the hospitals—who have not passed their sixteenth year. Not long since I saw in one of the general hospitals a youth of fifteen, who had enlisted as a drummer, but who had been placed in the ranks by his commanding officer, and made to carry the entire equipment of a soldier. The boy succumbed under the multiplied hardships of the Peninsular campaign, and was, when I saw him, in a condition of debility from which it is doubtful if he ever rallies so far as to become a healthy and hardy adult. Cases similar to this are by no means rare. They are found in all our hospitals, and doubtless in those of every other army in time of war, for it appears to be impossible, even when the effort is made, to keep these immature youths out of the service

A youth of eighteen has rarely attained his full growth. Dr. Liharžik, of Vienna, as quoted by Dr. Aitken,* in his little book, already referred to, comes to the conclusion that the growth of the human body is not completed till the end of the twenty-fifth year.

Mr. J. M. Danson† shows that a young man, who has reached the age of eighteen years, may still be expected to grow more than two inches before he is fully developed.

Quetelet, from numerous observations on soldiers, came to a similar conclusion. Tardieu,‡ in quoting Quetelet's results, says:—

"It is not sufficient that recruits should be vigorous and

* Op. cit., p. 63.

† Journal of the Statistical Society of London, March, 1862, p. 20.

‡ Dictionnaire d'Hygiene Publique, 1854, t. ii. p. 150.

well made; they should, in addition, be of that age at which they have acquired all their strength. This age with us appears to be twenty years. When this rule is violated, the number of victims is increased without adding to the strength of the army. A remarkable example of the importance of the age of soldiers is afforded by the campaign of 1805, in which the army marched four hundred leagues to reach the battle-field of Austerlitz, leaving scarcely any sick on the road. The youngest soldiers were then twenty-two years of age, and had been two years in service. In the campaign of 1809, the army, in cantonments in the German provinces, had a short distance to march. Before arriving at Vienna, it had filled all the hospitals with its sick. More than half of the young soldiers were under twenty years of age, having been enrolled prematurely."

Lévy* is scarcely less emphatic. Speaking of conscripts and volunteers, he says:—

"Voluntary enlistments relieve society of men who will not labor, and who, consequently, are useless. If their constitution is robust and their vocation certain, they become excellent soldiers, and from their ranks have come many illustrious generals; but, too frequently, discouragement and nostalgia ensue upon the enthusiastic love for the profession of arms. Moreover, at eighteen years, the nervous system is not consolidated, the pulmonary and digestive mucous membranes are very irritable; the organism not having yet attained to perfection, inadequately resists privations, etc. In general, the development of man is not attained before nineteen years, and this limit is prolonged, with many individuals, to twenty-five years; it follows that the minimum age for recruits should be rather the twenty-first or twenty-second year, than between eighteen and twenty years.

* Traité d'Hygiène. Paris, 1850, t. ii. p. 783.

The law has fixed from twenty to twenty-one years for conscripts, and from eighteen to thirty years for those who enlist voluntarily. Above thirty years, the habits of life are too inveterate, and the economy badly adapts itself to the exigencies of a new life. Over-young recruits have always had a sad fate. Witness the campaign of the spring of 1809, in which the army, consisting (to the extent of one-half) of soldiers twenty years old, strewed the road to Vienna with its sick; witness also the battles of Lutzen and Bautzen, where soldiers eighteen years old fought with veterans."

The results of the battles referred to are matters of history.

British authorities are fully as explicit on this subject as the French. Sir George Ballingall* says:—

"The age at which soldiers are enlisted is a point of much importance, and does not appear to have always met with that attention which it merits. Upon the principle of inuring men, from an early age, to those pursuits in which they are subsequently to be employed, it is generally thought that we cannot enlist men too young. There is nothing, however, in the duties of a soldier so mysterious as to prevent a man possessed of the necessary physical powers from learning them at almost any period of life; while, on the other hand, by enlisting boys before their growth is completed and their constitutions formed, it is quite impossible to foresee whether they will ever attain those physical powers necessary to capacitate them for the duties of a soldier; some of them will, perhaps, turn out better than we expect, but many of them will, in all probability, turn out worse, and will ultimately prove a loss to the service, or what are termed in the army the 'king's hard bargains.' It has been emphatically observed, that young

* Outlines of Military Surgery. Edinburgh, 1852, p. 29.

men fill the hospitals and not the ranks. 'I demand,' said Bonaparte, on a very memorable occasion, 'a levy of 300,000 men; but I must have grown men; boys serve only to incumber the hospitals and the roadsides.'

* * * * * * *

"Even in the continental armies," continues Sir George, "in which the troops are employed almost exclusively in their native climate, similar objections have been made to young recruits. It was said in derision of the Prince of Condé's army, that it would be a fine army when it came of age; and we find both from Kirckhoff and from Coche that they are decidedly opposed to premature enlistment. The latter, in his work "*De l'Operation Médicale du Recrutement*," states it 'as his deliberate opinion that recruits at eighteen years of age are commonly unfit for the duties of the army not only in time of war, but even during peace.' On the other hand, when men are enlisted for an unlimited period, it is important that they should not be admitted at too advanced an age; and upon a full consideration of all the circumstances, I think we may state that the most eligible period of life for enlistment is from twenty to twenty-five years of age." * * * *

Dr. Luscombe, in an excellent work on the Health of Soldiers, gives it as his "opinion, founded on observation and experience, that it is very prejudicial to the efficiency of an army to admit lads or very young men, for these are not only unequal to the fatigues of war, but their constitutions not being as yet firmly established, they are almost certain to suffer greatly from change of climate, and to become sickly even in the ordinary course of service."

Physiologically there can be no doubt upon the subject. The youth of eighteen years is immature; his bones are slender and deficient in the necessary amount of earthy matter to give them the proper hardness; the epiphyses are not yet incorporated with the shafts of the long bones, and,

in the ribs, are still cartilaginous; the joints are undeveloped, not having yet expanded sufficiently to give firmness and strength to the limbs; the muscles are soft, and have by no means acquired their full power, as is shown by the investigations of Quetelet and others; the chest has not attained its full capacity, and the contained organs have not yet reached the maximum point of efficiency.

In the digestive organs we find ample evidence of deficient power; substances which a mature man will digest with ease cause cholera morbus, diarrhœa, or dysentery in the recruit whose organization is not perfected.

Mentally also the evidences of weakness are frequently exhibited. While success attends the course of an army, the soldiers under the adult age are not prone to be depressed and discouraged; on the contrary, they are often excessively enthusiastic: but as soon as reverses ensue, or the food or clothing get to be deficient, or the weather changes for the worse, melancholy and nostalgia attack them, and they become at once worse than useless.

The growing age is not therefore that at which the best soldiers are formed. At this period all the energies of the body, physical and mental, are required to bring the organism to its perfect condition. Under the most advantageous circumstances this state of completeness is frequently not reached. The individual either succumbs from deficient vital power, or, as very often happens, certain parts or faculties of his body are arrested in their development, and remain in a comparatively degraded condition. How much more liable one or the other of these results is to ensue when the subject is exposed, from the vicissitudes of the military service, to hardships which require all the strength of the most robust to resist, is scarcely a matter for argument. Deficient food and clothing, absence of shelter, sudden and severe alternations of temperature, winds, snow, and rain, long marches, work in the trenches, the continued

and tremendous strain made upon all the forces of the body by battles, the crowding in badly selected, badly policed, and badly ventilated camps or barracks, bad cooking, bad water, bad air, all tell with greatly increased violence on the very young soldier, and ere long send him to the hospital to die, or to be discharged from the service. Scarcely any such return to their regiments.

Every observant medical officer of the army is cognizant, from his own experience, of these facts; every hospital in the service has many examples of them in the persons of the half-grown boys who are called soldiers, suffering from organic disease of the heart, phthisis, chronic diarrhœa or dysentery, rheumatism, debility, scurvy, or nostalgia.

From all this it follows that age is an important point to be considered in a recruit, and there appears to be no doubt that eighteen years is altogether too low a minimum. Place it at twenty to twenty-two, and we shall find fewer inmates of our hospitals, and consequently more men in the field; men, too, able to resist disease, to endure fatigue, and to bear up under the misfortunes and hardships to which all armies are subject.

In regard to the *maximum* age at which recruits should be accepted, the period for which they are required is the most important point to be considered. In our own service, where the enlistment was recently for five years and now but for three, recruits of thirty-eight years of age would, other things being equal, prove fully capable of rendering efficient service during the whole period of their engagement. But they would not make the *best* soldiers, for the reason principally that their habits of life have become set in some particular direction, rendering them more difficult of instruction and discipline than younger persons.

It is quite common, however, to meet with soldiers in the army who are entirely too old to render effective service. These have been brought out by patriotism, and,

consequently, are actuated by the highest possible sense of duty. They soon find, however, that they have overestimated their physical abilities. Often have I seen men over sixty years of age straggling along on the march, exhausted with fatigue from exertion, which was far from being severe for their young companions. Sooner or later they find their way to the hospitals, suffering from sheer debility, or crippled from chronic rheumatism.

The regulation is an excellent one—were it adhered to—which fixes the limit under which recruits for the army will be received at thirty-five years. Men between this age and fifty, or even fifty-five, are still capable of doing less arduous service than is required of an army in the field. They might be organized into corps for home defense or for garrisoning permanent works; but, as a rule, soldiers over forty-five years, who enter the service at that age, are not capable of performing the arduous and severe duties which devolve upon them in active warfare.

STATURE.—All civilized nations have had their attention drawn to the subject of the height of their soldiers, and all have fixed a minimum standard of height below which no recruits are received. The ancients thoroughly understood the disadvantages resulting from having very small men in the ranks, for we find that the minimum height for the Roman soldier was five feet two and a quarter inches, which is but little less than the American standard, (five feet three inches,) the highest adopted by any modern nation except Great Britain.

In the French army the minimum height is at present a little less than five feet one and a half inches, though formerly it was somewhat more than this. In the Austrian service the minimum is five feet for infantry, five feet one inch for cavalry, and five feet two inches for artillery. In the British army the standard is fixed at five feet five inches.

The disadvantages of soldiers being of very low stature are very obvious. In the first place, within certain limits men are strong, and can endure fatigue in proportion to their height. A soldier of medium height will carry more, work harder, and last longer than one considerably under the average stature; but I am satisfied, from much observation, that too great rigidity has been exercised in excluding men from the ranks by fixing the minimum standard at too high a limit. The Austrian soldier five feet high is fully capable, if of adult age, of enduring the greatest hardships, and can carry his equipment with as much ease as the American soldier of six feet and over, although, perhaps, is not so generally available for service as the man five feet eight inches high. But if the stature be less than five feet it will generally be accompanied with such slight development of the chest and muscles as will unfit the subject for the labors and fatigues of a military life; and therefore, as a rule, men under this height should not be permitted to enter the army.

In our own service the standard of five feet three inches is at present by no means strictly adhered to. It is not uncommon to meet soldiers of five feet who have stood their full share of duty and who are none the worse for it; and occasionally they are found even below this height, but broken down by a few weeks' campaigning, and only fit to be discharged.

Ordinarily the inhabitants of countries where food is abundant, and where the hygienic conditions of life are perfectly fulfilled, are of greater stature than those of localities where the opposite conditions prevail. Under the latter circumstances it is not only the height that suffers, but the muscles are small and weak, the heart feeble, the lungs contracted, and the brain wanting in that development which prompts to courage and activity and disdains hardship. Hence it is that the soldiers of very low

stature are, as we have said, generally found in the hospitals after a short term of service, debilitated both in mind and body.

The following table shows the comparative height of British and French soldiers in proportions of 1000. It is to be recollected that the British Army Regulations exclude from the service all persons under the height of five feet five inches, which accounts for the absence of soldiers under that stature.

Height.		British army.	French army, on authority of M. Hargenvilliers.	Height.		British army.	French army, on authority of M. Hargenvilliers.
Ft.	*In.*			*Ft.*	*In.*		
5	1	.....	62	5	10	128	9
5	2	.....	156	5	11	78	5
5	3	.....	187	6	0	40	2
5	4	.....	178	6	1	15	1
5	5	4	152	6	2	7	.....
5	6	114	107	6	3	1	.....
5	7	180	69	6	4	1	1
5	8	252	49	6	5	1	.....
5	9	184	22				

No one who has seen the French army can have failed to notice the low stature of the men who compose it. But at the same time he will doubtless have remarked the fact that nearly all of them are well proportioned, stout, and hardy-looking fellows.

The great height of American soldiers is shown by the following table, in which the results are given for eighteen hundred men, (one hundred from each State,) taken in the order in which they were entered in the Adjutant-General's office. The table is quoted from the *Medical Statistics of the United States Army from* 1839 *to* 1856.

State.	Mean height.	Six feet and over.	Greatest height.	
	Feet.		*Ft.*	*In.*
Indiana	5·7604	18	6	4¼
Kentucky	5·7729	18	6	3¾
Ohio	5·7537	15	6	3½
Tennessee	5·7779	18	6	3
Maine	5·7814	11	6	2
Vermont and New Hampshire	5·6951	6	6	1
Massachusetts and Connecticut	5·6821	5	6	3
North Carolina	5·7814	24	6	3¾
Georgia	5·8272	30	6	6½
South Carolina	5·7729	15	6	4½
Alabama	5·7647	17	6	4
Virginia	5·7488	15	6	2
New York	5·6505	4	6	1½
Pennsylvania	5·6756	5	6	1
New Jersey and Delaware	5·6509	6	6	1
Maryland	5·7180	9	6	2
Illinois	5·7696	17	6	3
Missouri	5·7162	8	6	1½

The great stature of the American, when compared with that of the English and French soldiers, is made sufficiently apparent from the foregoing tables. Of one thousand men in the British army, there were but sixty-five of six feet and over, and in the French army but four; while of eighteen hundred recruits for the United States army, two hundred and forty-one were six feet and over in height, or somewhat more than one hundred and thirty-three per one thousand. At the time the materials for this table were collected, no recruit under five feet five inches was accepted.

Dr. W. H. Thomson, appointed by the authorities of the State of New York to examine the recruits for the regiments in service from that State, has forwarded to me the results of his examination of 8632 persons who presented themselves to him in the City of New York for enlistment. Of this number but two were under the prescribed height of five feet three inches. One of these was an American and one an Englishman; 4500 Americans and 343 Englishmen were examined.

We have seen that very small men—that is, men under five feet in height—are not such as make the most efficient soldiers. Very tall men are often equally objectionable. Governments have not, however, thought it expedient to place a limit in this direction, and, therefore, we find more men of extreme height in service than of diminutive individuals. The tall soldier, such as one of six feet three inches, is not, as a rule, robust, and he breaks down much sooner—other things being equal—than the soldier of between five and six feet in height. What he has gained in altitude he has lost in amplitude, and his muscles easily become fatigued, from the facts that the levers they have to move are longer than those of his shorter comrade, and that they relatively do not possess as many fasciculi.

From the comparative narrowness of his chest, his lungs are inadequate to the work they have to perform in times of great activity. Hence he soon becomes "blown," as it is called.

Tall men are more subject to hernia than those of shorter stature. This is due to increased length and weight of the alimentary canal, and to deficiency of tone in the abdominal muscles.

They afford better marks for the enemy. This is a matter of no small importance, now that long range firearms are so generally used.

The prevailing opinion among military hygieists is, that too much desire has been shown to incorporate tall men into armies. This has been due to an anxiety to obtain men of imposing appearance, not because they were any better suited to the requirements of the service. Sir George Ballingall,* in alluding to this subject, says:—

"On the subject of stature and of bodily conformation, it may be observed that crowned heads seem in general to have a predilection for men of lofty stature and imposing

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* Op. cit. p. 31.

appearance; and what are termed the household troops, in this and other countries, consist of men much beyond the average height; but such men frequently owe their superiority to an additional length of limb, and are often found to have defective chests, very disproportioned to the bulk of their extremities. This renders them, particularly in our variable climate, subject to pulmonary diseases. I remember in going around the hospital of the Blues, one of the most splendid regiments in Europe, to have been much struck with the number of men laboring under pulmonary complaints, and was told by Dr. Hair, then surgeon of the regiment, that he scarcely ever lost a man from any other cause. Tall men are said to be more subject to disease generally, and particularly to diseases of the chronic class, than men of a medium size, and they are frequently the first to fail under fatigue. Men of this description, therefore, are not the most eligible for the general run of military duties."

Very tall men do not make the best soldiers physically, unless their height is accompanied by proportional development of the chest and muscular system. Ordinarily persons over six feet three inches in height are not sufficiently developed in the parts mentioned, and should not accordingly be allowed to enter the service.

It may be supposed that we are over-exclusive in this particular. It is to be recollected, however, that unless a man is fitted to perform the duties of a soldier, always arduous and often extremely severe, he has no business in the army. Instead of being useful he is a burden. One able-bodied man is worth a dozen of those who either do no duty at all or perform their allotted share in an imperfect manner. The one is to be depended on, the other is altogether unreliable.

Considered physiologically, the subject of the height of men and the circumstances which influence it are of very

great interest. Some reference has already been made to it in these connections, but we cannot dismiss the matter without dwelling upon it with somewhat more of detail, for we are satisfied that much injury is done both to individuals and to governments, by allowing persons whose growth is not completed to enter upon a military life.

The full growth of the human body, in the male, is scarcely ever attained before the twenty-fifth year; in the female it is more rapid, and is reached generally by the termination of the eighteenth or nineteenth year.

Now there are various circumstances which may retard or hasten this development, and which may arrest it altogether—insufficient food and clothing, deprivation of light and pure air, excessive manual labor, over-exertion of the mental powers at an early age, want of physical exercise, the action of a rigorous climate, are all so many counteracting agencies to the full attainment of the growth. As Villermé* remarks, poverty and misery cause a predominance of persons of low stature, and restrain the complete development of the body.

The proofs of these assertions are seen everywhere, but especially in the manufacturing districts of Europe, where the circumstances mentioned are to be found in full operation with the production of their legitimate results. In the department of the Bouches de la Meuse, (now a part of Holland,) a region made rich by the industry and enterprise of its inhabitants, and where the people are not overworked in infancy and youth, and are well fed and provided for, the mean height of the conscripts, in 1808, 1809, and 1810, under the age of twenty years, was five feet two inches; while in the department of the Apennines, mountainous, with no industrial resources, poor, the people broken down

* De le Taille de l'Homme en France. Annales d'Hygiène, tome i. p. 386.

at an early age by excessive labor, and badly nourished, the mean height of the conscripts for the three years cited was but four feet nine inches. Moreover, in the department of the Bouches de la Meuse, the number rejected was but sixty-six per thousand, of which forty-two were for diseases, and twenty-four for being under the height of four feet nine inches; while in the department of the Apennines, the number rejected was three hundred per thousand—two hundred and four for being under size, and ninety-six for deformities, sickness, and other physical disability.

As Villermé, from whose memoir these results are obtained, remarks: "The difference is striking. Where the height is greater there are fewer rejected, even on account of diseases; and when, on the contrary, the stature is low, there are many set aside even for this last cause; so that all the advantages are with the men of high stature."

The effects of a rigorous climate and a poor soil in diminishing the height of the inhabitants are seen in the regions of the frigid zones. It is very rarely the case that the Greenlanders, Siberians, and other people living in countries similar to theirs, attain to the altitude of five feet.

We see the operation of the same law in the stunted vegetation which prevails in high latitudes, and the extreme height to which vegetable organisms grow in equatorial regions.

It has been established also that the inhabitants of civilized countries are of greater stature than those of barbarous regions. Even in the same countries the people have become taller as civilization has advanced. We hear a great deal about the physical degeneracy of the human species in consequence of the increased luxurious mode of living at the present day, but it may be accepted as a well-ascertained fact that bodily development is in direct proportion to education, refinement, and intelligence. We see this law in force in the lower animals and in vegetables, which

always acquire more perfect development by taming and careful attention.

The researches of M. Villermé* also show, what was not previously supposed, that the inhabitants of cities are taller than those of the agricultural districts. The investigations of M. Quetelet† confirm this conclusion. This observer found that the mean height of the men in three cities of Belgium, deduced from observations extending over five years, was in the mean 1·6485 metres, while in the rural districts it was but 1·6275 metres.

We have said that, as a rule, the growth of the body in the male is not completed before the twenty-fifth year. Quetelet not only confirms this law, but even places the period of full growth at a somewhat later period. At nineteen years of age, he found the mean height to be 1·6648 metres, at twenty-five 1·6750 metres, and at thirty years 1·6841 metres.

As Dr. Aitken‡ has very properly remarked, the only manner of considering the question of height for military purposes is with reference to the age. "If the height of the soldier is the main qualification to be looked for in selecting the recruit, then the age must be in accordance; for example, if men five feet eleven inches or six feet are in demand, then the age of such men should be not less than twenty to twenty-five years, and the weight not less than 160 to 180 pounds. We know that there are limits to the rate of growth affixed to the constitution of each individual, and although men may vary as to height within certain physiological limits, the age being the same, yet the

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* Recherches sur la Loi de la Croissance de l'Homme. Ann. d'Hygiène, tome vi., 1831, p. 93.

† Sur la Taille moyenne de l'Homme dans les villes et dans les Campagnes, etc. Ann. d'Hygiène, tome iii. p. 24.

‡ Op. cit., p. 48.

height of the recruit should never be more than the age justifies." And again:—

"If *eighteen years* of age is to be the minimum fixed for the enlistment of 'growing lads,' then the *height* should be as near as possible five feet four inches, and the *weight* as near as possible 112 pounds. The height at eighteen years of age ought not to be *below* five feet two inches, and certainly not *below* five feet. At an age so young as eighteen, a height *below the average* is apt to have been the result of defective feeding in early life, tending to a diminution of the normal rate of increase and growth of the body. Under such circumstances stunted development and diseased vital processes are the inevitable consequences. The constitutional tendencies of the future being are thus more or less certainly fixed at an early age; and although at the age of eighteen the recruit may have no evident disease, yet a *minimum* height and weight at that age will indicate a decided tendency to constitutional disease. On the other hand also, as the height approaches a *maximum* at the age of eighteen, the excess of growth of the body generally, compared with the expansion, growth, and vital capacity of the lungs, becomes sufficiently obvious by the contrast of the tall body with the narrow and flat chest in which the apices of the lungs approach close to each other. Generally in such cases the reparative organs are out of proportion to the body which has to be sustained."

Closely connected with the height of the individual is another element in the adaptability of the recruit for military service, and that is

THE CAPACITY OF THE CHEST.—No physical point is of more importance than this. The size of the chest not only affords us a correct idea of the respiratory power of the individual, but is a valuable index of his general strength. A person with an under-sized thorax is generally of strumous diathesis, a condition of body which indicates deficient vital

power of the whole body, and which, when strongly marked, unfits the soldier for the thorough performance of his duties.

Authors differ in regard to the minimum circumference of the chest which should be insisted on for soldiers. We are of the opinion that no one in whom the circumference of the chest immediately over the nipples measures less than half the height of the individual should be accepted. Many soldiers are found in service with less capacity of thorax, but they are weak, puny, and altogether insignificant, breaking down under the least fatigue, and more frequently found in the hospitals than in the field.

With reference to the external dimensions of the chest relatively to the height, Mr. Brent* has furnished some very valuable indications. These may be formularized as follows:—

Relation of the external chest to the height, measured over the nipples.

Minimum chest: $\frac{1}{2}$ of the stature — $\frac{1}{61}$ of the stature = circumference of chest.

Medium chest: $\frac{1}{2}$ of the stature + $\frac{1}{15}$ of the stature = circumference of the chest.

Maximum chest: $\frac{2}{3}$ of the stature = circumference of chest.

To apply these rules to practice, take an instance of a man five feet one inch in height.

Minimum chest: height 61 inches, $\frac{1}{2}$ = 30·5 inches — $\frac{1}{61}$ = 29·5 inches circumference of chest.

Medium chest: height 61 inches, $\frac{1}{2}$ = 30·5 inches + $\frac{1}{15}$ (= 4·07 inches) = 34·57 inches circumference of chest.

Maximum chest: height 61 inches, $\frac{2}{3}$ = 40·7 inches circumference of chest.

Taking men of minimum, medium, and maximum weight

* Quoted by Hutchinson. Cyclopedia of Anatomy and Physiology, art. *Thorax*.

at various heights, the external circumference of the chest should be as is shown in the following table.

Males—Circumference of Thorax.

Height.		Minimum weight.	Medium weight.	Maximum weight.
Ft.	*In.*	*Inches.*	*Inches.*	*Inches.*
5	0	29¾	34	37⅛
5	1	30¼	34¾	37¾
5	2	30¾	35¼	38⅝
5	3	31¼	35⅞	39
5	4	31¾	36¾	39⅝
5	5	32¼	37	40¼
5	6	32¾	37½	40⅞
5	7	33¼	38⅛	41½
5	8	33¾	38⅝	42⅛
5	9	34¼	39⅛	42¾
5	10	34⅝	39⅝	43¼
5	11	35¼	40½	44
6	0	35⅝	40¾	44⅝

Thus it is seen that the minimum chests increase four-eighths of an inch for every additional inch of height, the medium chests a little more than this, and the maximum chests five-eighths of an inch.

Disregarding height, Hutchinson found, from observation of 1276 cases, that the circumference of the chest increases exactly one inch for every ten pounds increase of weight.

Brent also arrived at several other interesting results. Thus he found that the circumference of the thorax, over the nipples, is equal to twice the breadth of the shoulders, measured from point to point. If the caliber of the shoulders therefore be eighteen inches, the circumference of the chest will be thirty-six inches. Four times the distance between the nipples is equal to the circumference. Four times the antero-posterior diameter is equal to the circumference. Therefore the distance between the nipples is equal to the depth of the external thorax from before backward. At the height of five feet nine inches, this antero-posterior diameter varies from seven and a half inches to twelve and a quarter inches.

I have been at considerable pains to ascertain the accuracy of these measurements, and have arrived at conclusions entirely confirmatory of them. The rules appear to hold good for all cases in which there is not positive deformity. We have therefore very simple methods at our command for determining the external circumference of the thorax.

For measuring the circumference of the thorax a graduated tape may be employed; this is placed around the chest over the nipples. A more convenient method, however, is to measure the distance between the nipples with a pair of dividers, or a graduated rule, and to multiply the result by four. As we have seen, this gives us the entire circumference of the chest. For measuring one side of the chest, one end of the tape should be placed at a point on the sternum midway between the nipples, and the distance measured between this point and a spinous process of a vertebra upon the same plane.

It is important not only that the chest should be large but that it should be symmetrical. Malformation of the chest is produced by various causes, such as disease, occupation, or intentional constriction.

Diseases of the lungs, pleura, or heart may make one side of the thorax larger or smaller than the other. Angular or lateral curvature of the spine, from disease of the vertebræ, or a want of tone in the muscles which maintain the spinal column in an erect position, cause great deformity of the chest.

What is called "chicken-breast" appears to be due to repeated attacks of dyspnœa, or some condition by which a constant difficulty is experienced in inspiring a sufficient quantity of air. Dupuytren noticed the occurrence of this species of malformation in conjunction with enlargement of the tonsils, and Mr. Shaw,* who was, we believe, the first

* London Medical Gazette, vol. i., 1842.

to study the subject philosophically, confirms this observation. In a case which came under his charge, in which "chicken-breast" existed along with tonsillar disease, he excised the tonsils, with the effect of entirely removing the deformity of the chest. The rationale of the causation of this alteration in the shape of the chest is explained by the fact that powerful efforts are made to inhale air while but little really enters. In consequence of the great flexibility of the ribs, in childhood, the atmospheric pressure overcomes the action of the muscles, and the sides of the thorax are forced inward, at the same time pushing the sternum forward.

In clerks, tailors, and others who pursue sedentary occupations which require them to bend forward for lengthened periods, the chest frequently becomes flattened anteriorly. In compositors this condition is very generally met with, and, as a consequence, this class of artisans is very subject to phthisis and other lung affections.

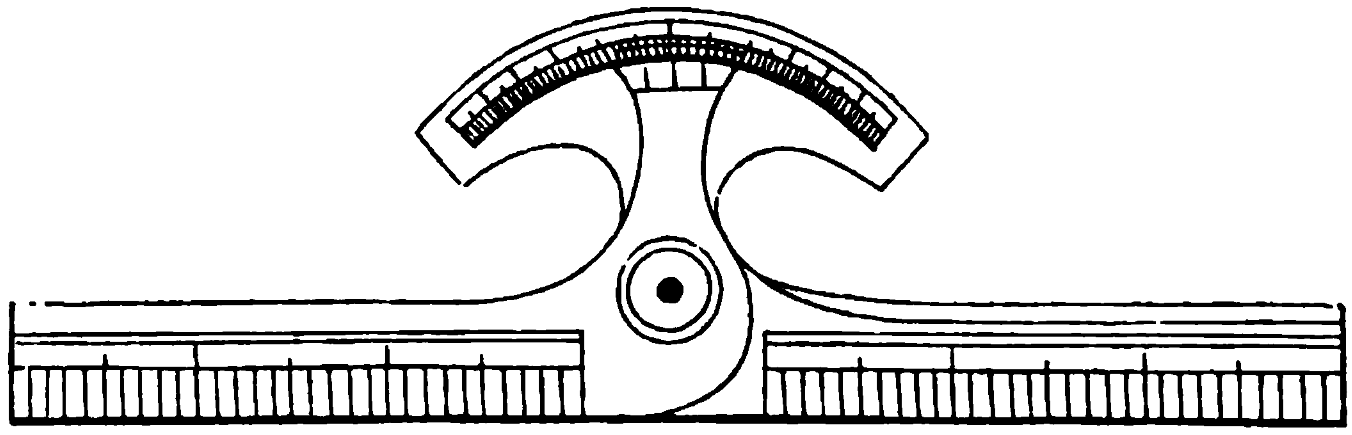
In very young soldiers who have gone into the field without much training, flattening of the chest is quite commonly observed. Here it is due to the constant stooping forward while marching, in order to secure a better purchase for the knapsack and other articles of the equipment. Several cases have come under my observation in which the individuals were straight and with medium-sized chests previously to entering the army, in whom very considerable flattening of the anterior thoracic wall and rounding of the shoulders were produced in a few months from this cause, with the consequent development of tubercular disease of the lungs.

The effect of pressure in altering the form of the thorax is well observed in those females who wear tightly-laced corsets. Here the form of the chest is entirely reversed: instead of the apex being above, it is below. Cruveilhier has observed that infants born with the thorax perfectly

well formed, may have it permanently deformed through pressure exerted on the sides by the hands of the nurse.

With reference to alterations in the external form of the thorax, the stetho-goniometer of Dr. Scott Alison* (Fig. 1) will be found the best instrument with which to ascertain their extent, though, for practical purposes before enlistment, the eye alone will afford sufficiently accurate data on which to form a competent judgment.

Fig. 1.



Thus much in regard to the external measurement of the chest, a means by which we can generally obtain sufficiently correct ideas relative to the capacity for respiration, in healthy individuals at least, but which, in disease, is not such as affords exact results.

The capacity of the lungs may be ascertained, with due precautions in its management, by means of the spirometer of Mr. Hutchinson. (Fig. 2.)

This consists of a vessel containing water, out of which a receiver is raised by breathing into it through a tube; the height to which the receiver is raised indicates the capacity of the lungs, *plus* the residual air which cannot be expelled.

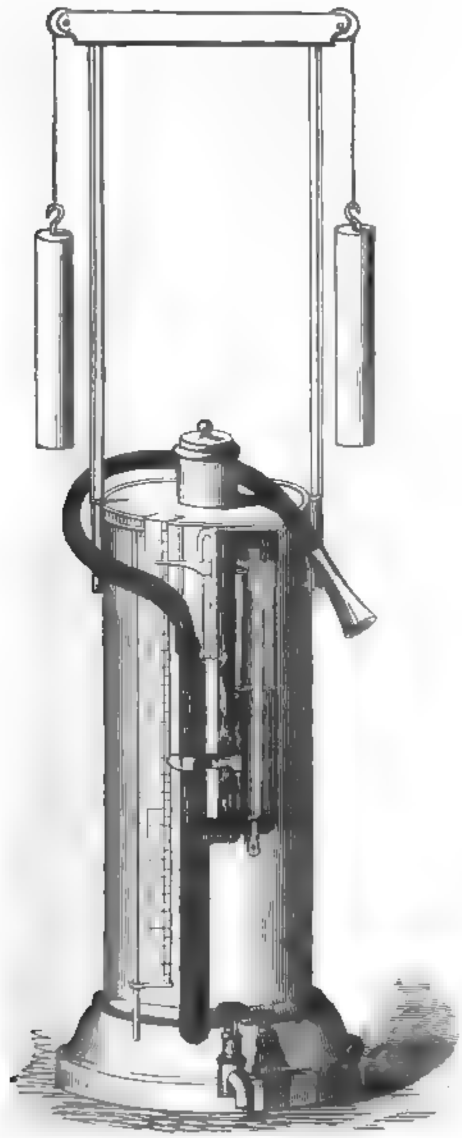
According to Hutchinson, the "vital capacity," as he calls it, is a constant quantity, and is not increased by habit. It is, however, modified by the following circumstances:—

First, by height; second, by position; third, by weight; fourth, by age; fifth, by disease; to which we may add

* On Measuring the Configuration of the Chest in Disease. Beale's Archives of Medicine, No. ii. p. 60.

sixth, by the state of the stomach as to repletion; and seventh, by the muscular power of the individual.

Fig. 2.

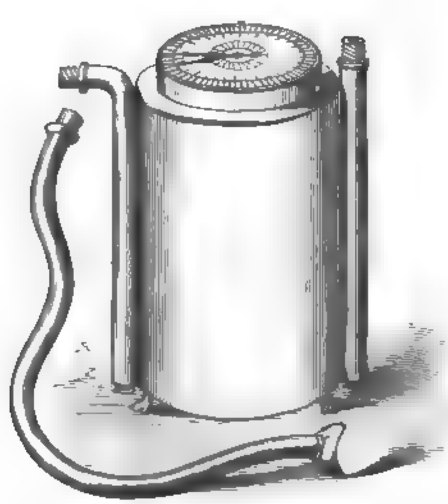


These circumstances are so numerous, and exercise so material an influence over the results obtained, that the

spirometer is not regarded as of much value in investigating cases of disease; and however decided Mr. Hutchinson may be relative to the results not being under the influence of habit, we are satisfied that he is mistaken on this point.

Nevertheless the observations of Mr. Hutchinson are very important, and physiologically teach some very valuable truths.*

Fig. 3.



A spirometer, made upon the plan of the dry gas meter, has been for some time employed in Germany, and was introduced into use in this country by Dr. S. Weir Mitchell. It is altogether more simple in its management than the rather clumsy instrument of Hutchinson, and affords fully as accurate results. (Fig. 3.)

The *mobility* of the thorax is a point of much importance, and may be roughly ascertained by means of the tape measure. The tape is passed around the chest over the nipples, and the measurement made when the chest is distended to its utmost capacity with air. It is then measured

* See article Thorax, in Cyclopedia of Anatomy and Physiology, for a full view of Mr. Hutchinson's investigations.

when the air has been as far as possible expired. The difference gives the mobility. In most healthy men this will be found to be somewhat over three inches. If it is considerably less than this, disease may with confidence be suspected.

Fig. 4.

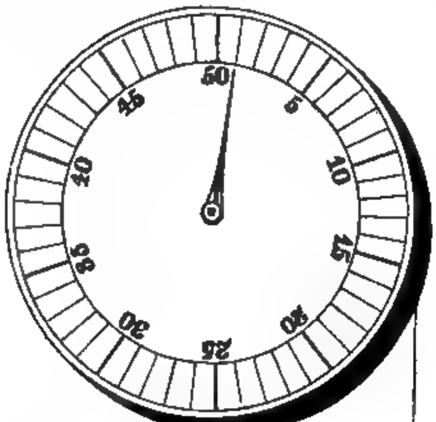
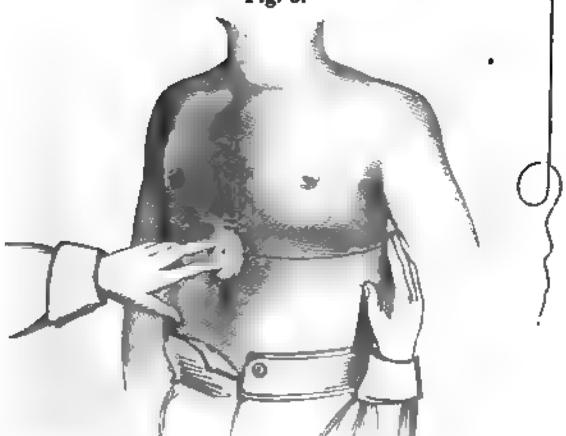


Fig. 5.

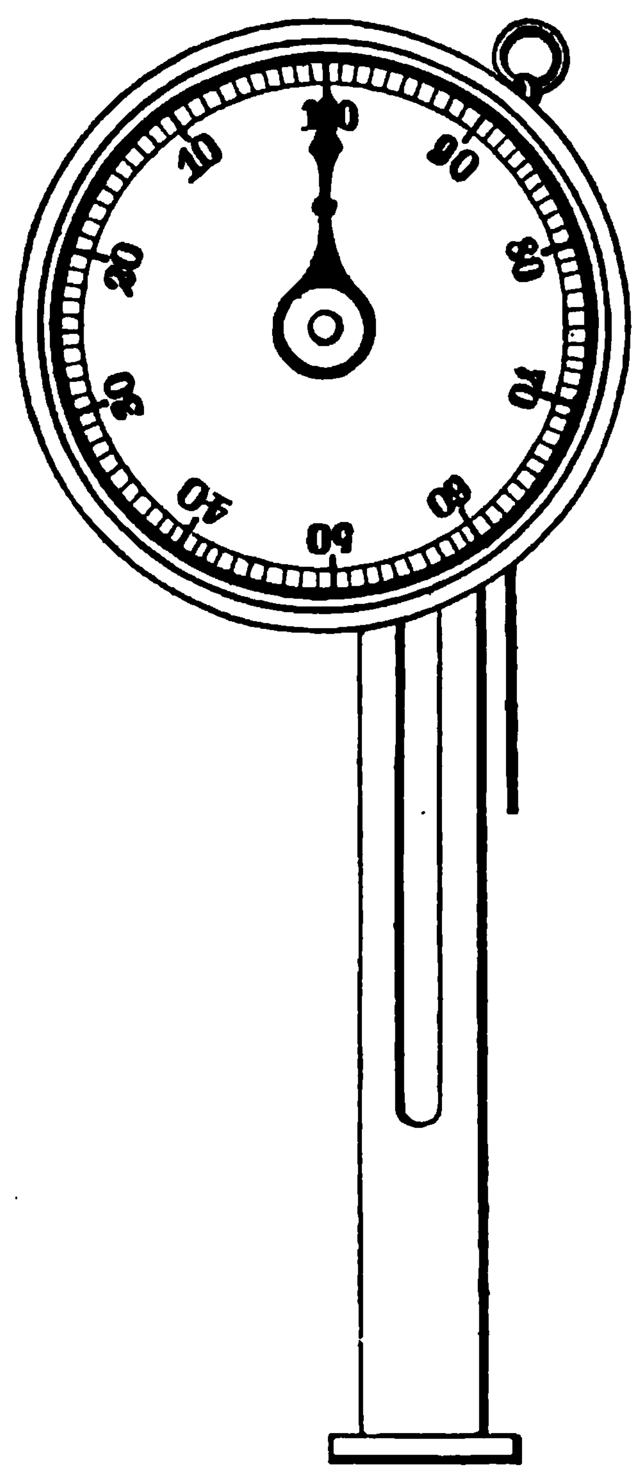


For accurately determining the extent of motion of the chest the stethometer of Dr. Quain, or the chest measurer of Dr. Sibson, may be employed. Dr. Quain's instrument (Fig. 4) consists of a circular brass box resembling a watch.

An index, moved by a rack attached to a string, traverses the dial. One revolution of the index corresponds to one inch of motion in the chest. The dial is graduated to hundredths of an inch. To use the instrument, the box is placed over the sternum and the string carried around the chest, as shown in the figure. (Fig. 5.)

Dr. Sibson's instrument is constructed on the same principle, the index being, however, attached to a pinion instead of a string. (Fig. 6.) The pinion is placed on the

Fig. 6.



nail of the observer's finger, which rests on the chest, and moves with it, while the body of the instrument is held in the other hand, as shown in the figure. (Fig. 7.)

The movements of the chest, as indicated by either of these instruments, are not extensive, and the results do not

Fig. 7.

entirely admit of comparison with those obtained by the tape measure, and in the manner described. The former give the mobility of certain parts of the thoracic parietes only, while the latter determine the relative circumference of the chest, when the lungs are full of air or emptied, as far as is possible. Dr. Sibson gives the following table of results, obtained for different portions of the chest, indicated in one-hundredths of an inch:—

Instrument applied to—	Side.	Involuntary tranquil respiration.	Voluntary forced respiration about
Center of sternum, between second costal cartilages		8 to 6	100
Second rib, near the costal cartilage.	right	8 to 7	110
	left	8 to 7	110
Lower end of sternum		2 to 6	95
Fifth costal cartilage, near rib	right	8 to 6	95
	left	2 to 6	85
Sixth rib at the side	right	5	70
	left	3	60
Tenth rib	right	10	65
	left	9	60
Abdomen	center, boy	25	90
	center, man	25 to 30	100
	right	9	
	left	8	

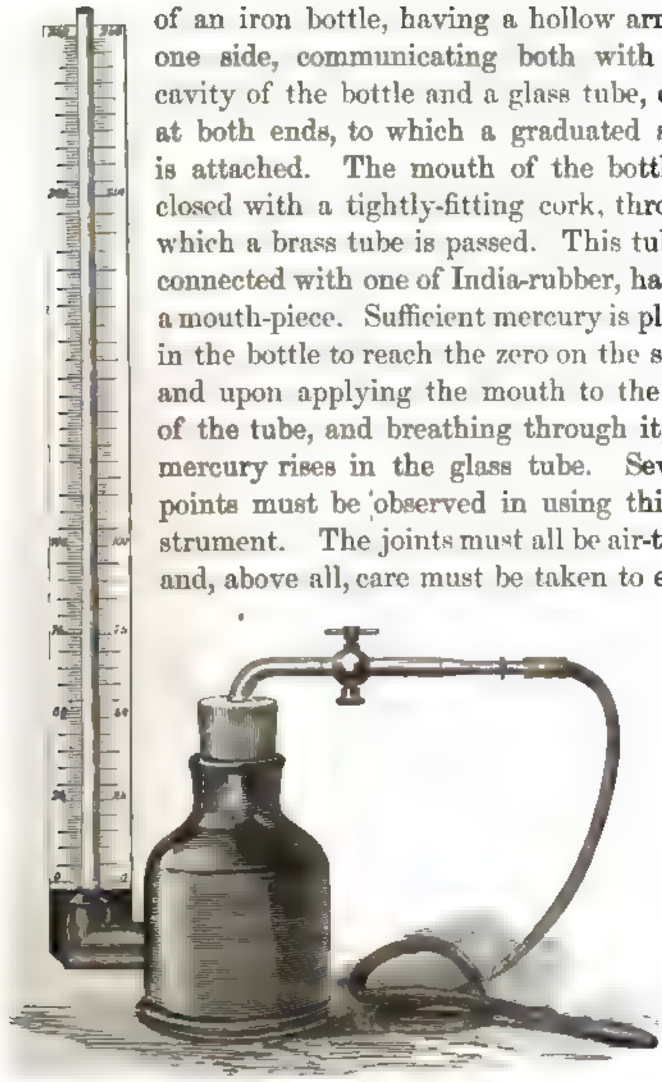
Bennett,* in considering the subject, says:—

"In disease it may be observed, as a general rule, that if the respiratory movements are increased in one place, they are restrained elsewhere. We have already alluded to the relation existing between thoracic and abdominal movements. The amount of these may be exactly ascertained by the chest-measurer. In the same manner, the diminished movements on one side of the chest in pleuritis, pneumonia, and incipient phthisis can be determined and compared with the exaggerated motion on the opposite. Thus, in phthisis, instead of the indication of the instrument, placed over the second rib on the affected side, moving between one and one hundred and ten in forced inspiration, as in health, it may only move between one and thirty. In making observations with the chest-measurer, considerable practice and skill are necessary, as in the employment of all other instruments. It enables us to arrive at great accuracy, and constitutes an extra means of exploration, without, however, being absolutely necessary for arriving at a correct diagnosis in every case."

* Clinical Lectures on the Principles and Practice of Medicine, p. 37. Third edition. Edinburgh, 1859.

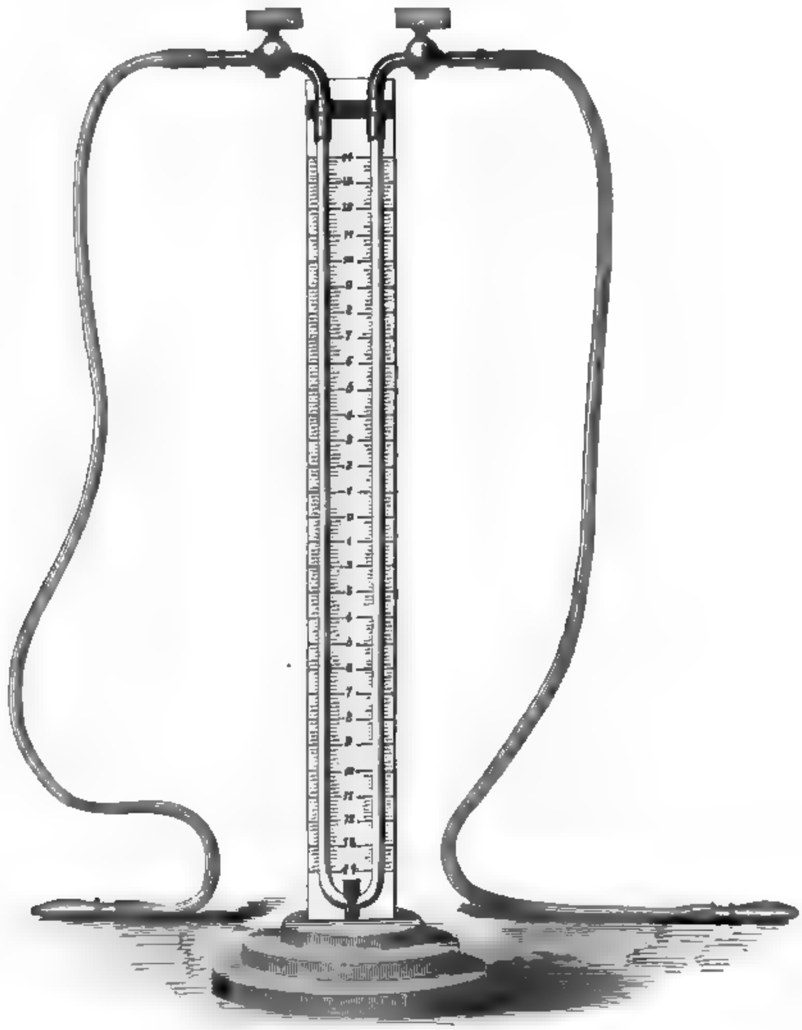
The respiratory power of an individual may be ascertained by the cardiometer or the hæmadynamometer. The former, modified somewhat for its present use, is represented in Fig. 8. It consists of an iron bottle, having a hollow arm at one side, communicating both with the cavity of the bottle and a glass tube, open at both ends, to which a graduated scale is attached. The mouth of the bottle is closed with a tightly-fitting cork, through which a brass tube is passed. This tube is connected with one of India-rubber, having a mouth-piece. Sufficient mercury is placed in the bottle to reach the zero on the scale, and upon applying the mouth to the end of the tube, and breathing through it, the mercury rises in the glass tube. Several points must be observed in using this instrument. The joints must all be air-tight, and, above all, care must be taken to exert only the muscles of the chest, and not those of the mouth and cheeks. This instrument only measures the *expiratory*

Fig. 8.



power. The hæmadynamometer enables us to determine both the expiratory and inspiratory power, and is therefore more useful. (Fig. 9.)

Fig. 9.



It consists of a bent tube of glass, attached to a scale graduated for both sides. An India-rubber tube is attached to one end of the glass tube, to which a suitable mouth-

piece is affixed. Mercury is poured into the glass tube till the zero on both scales is reached. Upon expiring into the arrangement, the mercury is forced to rise in the opposite portion of the tube, and is correspondingly depressed in the portion to which the elastic tube is attached. When the act of inspiration is performed, the opposite movements of the mercury take place. The same precautions are requisite as in using the cardiometer.

The height to which the mercury may be raised is greater by expiratory than by inspiratory efforts. A healthy man, five feet eight inches high, can raise the column of mercury about three inches by expiration, and about two inches by inspiration. The former is, however, much more irregular in its action than the latter, from the fact that the muscles of expiration perform other functions than that of simply expelling the vitiated air from the lungs, while those of inspiration are only concerned in providing for a free entrance of a fresh supply of air into the chest. The inspiratory power is, therefore, that which furnishes the more valuable indications relative to the health of the individual.

Height exercises a very considerable influence upon the inspiratory power. According to my own experiments, men of five feet eight inches possess it to the greatest extent. From this point it decreases both as the height decreases and increases, which is certainly a very remarkable fact. Hutchinson has arrived at similar conclusions.

Occupation also influences the respiratory power. Persons of sedentary vocations have it to a much smaller extent than those whose business requires much muscular exertion.

The hæmadynamometer employed as referred to is worthy of being more extensively used in the examination of recruits than has hitherto been the case.

In this country it has scarcely at all been employed, though the indications it yields are of the utmost import-

ance in determining the fitness of an individual for service where great strength and endurance are required. It is easy of application, and requires no special training of the person submitted to examination.*

WEIGHT.—The weight of the recruit is of very considerable importance, especially when taken, as it always should be, in connection with the age, height, and other physical circumstances. It is very evident that one hundred and fifty pounds weight, though perfectly sufficient for an individual twenty years old, and five feet five inches high, is not that which should be possessed by one twenty-five years of age, and six feet two inches in height.

According to Quetelet,† a man does not attain his maximum weight till he is about forty years of age; toward sixty he begins to decline, so that by the time he has reached his eightieth year he has lost about fifteen pounds. In the same period his height has fallen three-tenths of an inch.

Women attain their maximum weight at a later period than men—toward fifty years of age—but they lose at about the same rate.

Immediately before puberty, both men and women weigh half as much as they will when their development is completed.

For corresponding heights, American soldiers are not so heavy as those of European armies. The former do not grow laterally to the same extent as the last mentioned, and hence their deficiency in weight. This is the greatest defect in the physical constitution of our troops—a defect, however, which, while it makes them less capable of en-

* Mr. James W. Queen, of No. 924 Chestnut St., Philadelphia, constructed for me, two or three years ago, an excellent hæmadynamometer, which, so far as I know, is the only one ever made in this country.

† Recherches sur le Poids de l'Homme aux differens Ages. Annales d'Hygiène, etc., t. x. p. 5, 1833.

during long-continued fatigue without succumbing to its influence, renders them more able to perform labors in which activity and rapidity of movement are necessary.

It is manifestly impossible to fix any absolute minimum standard of weight for recruits, unless, as we have said, it be done in accordance with the age. But in this connection it would be very desirable that a limit should be established below which no recruit should be accepted. For instance:

A man at twenty years of age should weigh not less than one hundred and twenty-five pounds. If he weighs less than this, there is probably some disease, or constitutional tendency to one, which will render him unable to master the hardships of military life. Weight is usually accompanied with stamina, unless it be due to obesity, which of itself constitutes a disease.

With a less weight than that indicated for the recruit of twenty years of age, the chest will be of smaller capacity than the normal standard, the muscles will be weak and flabby, and the digestive system lacking in tone; all of which are disqualifications which, after a short period of service, will bring him to the hospital, generally never to return to the field.

Every recruiting rendezvous should be furnished with a good set of platform scales, capable of turning with a fourth of a pound when fully loaded, and every person applying for enlistment should be weighed, and rejected if found deficient.

From eighteen to thirty-five, (the limits under which recruits are received, according to regulations, into the American army,) the weight gradually increases. There is likewise an increase of weight as the height increases. This should be at least five pounds for each inch of height above five feet five inches. Placing the minimum weight at this height at one hundred and twenty-five pounds, and we have the following scale :—

Height.		Minimum weight.	Height.		Minimum weight.	Height.		Minimum weight.
Ft.	*In.*		*Ft.*	*In.*		*Ft.*	*In.*	
5	5.....	125	5	10.....	150	6	3.....	175
5	6.....	130	5	11.....	155	6	4.....	180
5	7.....	135	6	0.....	160	6	5.....	185
5	8.....	140	6	1.....	165	6	6.....	190
5	9.....	145	6	2.....	170	6	7.....	195

Weak Constitution.—When an individual presents a feeble development of animal life, as is induced by contracted chest and deficient weight, together with coldness of the extremities and a weak circulatory apparatus, we say that he is of "feeble constitution." Such an individual may, upon the most careful examination, show no signs of positive disease, and yet all his functions are performed in such a manner as barely, with the greatest care on his part to avoid exposure to every morbific agent, to carry him through life. When subjected to any influence out of the ordinary routine of his existence, the effect is immediately seen. The slightest indiscretion in diet, a change of weather, moderately severe exercise, or the want of his customary rest, produce an effect upon him which stronger individuals would not experience.

Such persons are not fitted for army service. Attention to the rules we have laid down in the foregoing pages relative to age, height, capacity of the chest, and weight, will enable us to make a competent judgment in all such cases.

General Aptitude.—An opinion in regard to the general aptitude of a recruit for military service can only be formed from a careful consideration of the points which have already been brought under notice, together with an examination into his habits and intellectual development. An immoral, a drunken, or an imbecile or deranged man is unfit for the army; but besides being free from vices, and of healthy mind, the soldier ought to be so constituted as to be capable of feeling a lively interest in his profession,

and of looking with a genial mind on things around him. It is, perhaps, impossible to estimate a man's character in this respect before enlistment, nor, in many cases, even if ascertained to be altogether unsuitable, would the fact be sufficient cause for rejection; but it is difficult to over-estimate the good results, both to the individual himself and to those about him, which flow from a cheerful and contented disposition. Hardships are under-estimated, fatigues are unfelt, defeats do not depress, but a healthy *morale* is kept up under the most adverse circumstances. Men thus constituted are invincible; they encourage each other, and embolden their generals to attempt undertakings which would never be dreamed of with an army of grumblers.

CHAPTER II.

SPECIAL QUALIFICATIONS AND DISQUALIFICATIONS OF RECRUITS.

The subjects of inquiry under this head may properly be considered as indicated by the anatomical division of the body into regions and organs.

1. The Scalp and Cranium.
2. The Cerebro-spinal Axis.
3. The Eyes and Ears.
4. The Nose.
5. The Mouth.
6. The Neck.
7. The Chest.
8. The Abdomen.
9. The Genito-Urinary Apparatus.
10. The Upper and Lower Extremities.
11. The Skin.

THE SCALP AND CRANIUM.—The scalp should be free from chronic eruption and tumors, and should be well covered with hair. The existence of favus, pityriasis, eczema, alopecia, large tumors, ulcers, or extensive cicatrices produced by great loss of substance, are disqualifying causes for enlistment, several of them as well for hygienic considerations arising from a regard for the health of the future comrades of the applicant, as from a conviction of their rendering the individual himself unfit for service. The cutaneous eruptions mentioned are liable to spread by contagion, and are especially difficult of cure. Alopecia is injurious, from the fact that the head is deprived of its natural covering, and exposed to cold and heat.

Tumors may be either of the scalp or cranium; in the former case they are, if small, of little consequence, as they are generally of the encysted variety. If large, however, they interfere more or less with the efficiency of the soldier, and are a sufficient disqualifying cause.

Ulcers of the scalp are usually indicative of constitutional disorder, and are due to a strumous or syphilitic taint.

Cicatrices should be carefully examined, with a view to ascertaining their cause, and the detection of any injury which may have been given to the skull. They are always suspicious. If there has been much loss of substance, the recruit should be rejected.

The cranium should be examined carefully, in order to detect any injury or vicious conformation which may be present. Fractures, if there has been loss of or depression of bone, should be regarded as unfitting a man for the military profession. In many cases a predisposition to epilepsy or other affection of the brain is engendered. I knew a case in which the subject had fractured his skull by being thrown from a railway car. Recovery ensued after long-continued unconsciousness, and the loss of eighteen square

inches of bone. There was a depression in the scalp over the right side, in which the hand could be placed. Eighteen months after the reception of the injury epilepsy ensued. The fits were very frequent and severe, and in one of them he expired.

The cranium may be of *abnormal form*, or of *exceedingly small capacity*. In such cases there is usually some degree of imbecility of mind. It may be considered as a rule, with scarcely an exception, that the skull of an adult measuring less than twenty-two inches in circumference, denotes more or less idiocy.

Tumors of the cranium are always disqualifying causes. They may be due to a syphilitic taint, but none the less unfit the possessor for the military service.

Imperfect ossification of the cranial bones of course renders the subject unfit for service.

THE CEREBRO-SPINAL AXIS.—*Idiocy*.—When well marked, idiocy can always be detected, even by the most cursory examination. Cases of the admission of idiots into the army have however occurred, owing, doubtless, to the fact that there has been no examination at all. Individuals occasionally present themselves for enlistment who, though not decidedly imbecile, are possessed of such weak intellects as to prevent their ever becoming efficient soldiers. Such men should always be rejected. The day when soldiers were regarded as mere machines has passed away. An intelligent man, who knows what he is fighting for, and who is capable of appreciating the responsibility that rests upon him, is incomparably a better soldier than one who is incapable of such intellectual action. Moreover, weak-minded soldiers can never be depended upon to perform the duties to which they may be assigned. On guard, for instance, they are not only useless, but positively unsafe; because they are incapable of taking an intelligent view of the relations which surround them.

Idiots are less able to resist the influence of certain morbific agents than those of sane mind. Thus they are more liable to inflammatory diseases and to those of malarious origin, and certainly are more deficient in physical as well as mental power. A tendency to epilepsy is also generally present.

It is frequently a difficult point to decide, without a more careful examination than can be given by a medical officer at an inspection for enlistment, as to the intellectual capacity of the recruit. Much may be ascertained in doubtful cases, however, by careful questioning in regard to the parentage and associations of the individual. Where the parents have been of the same blood, or where the person has been exposed to those influences which are liable to cause a degeneration of the intellect, such as bad alimentation, the excessive use of intoxicating substances, abuse of the generative organs, or long-continued deprivation—especially in early life—of the hygienic advantages of air, light, clothing, etc., he should be rejected as unfit for the profession of arms.

Insanity requires still more caution on the part of the examiner, for many insane persons are possessed of sufficient cunning to deceive even those most experienced in the management of such cases. Monomaniacs especially are at times exceedingly difficult of detection, and in spite of the most rigid examination will obtain entrance into the service. I have seen several, who were very troublesome to all about them, who had been enlisted without any examination, and who had to be discharged.

Epilepsy should always be watchfully looked for, as it entirely unfits the person afflicted for the duties of a soldier. It is much more common than is generally supposed, and not a few cases are found in the army. No man who has had an epileptic seizure should be accepted as a recruit, and all cases of it should be immediately discharged from

service. An experienced examiner will rarely have any difficulty in detecting it in those who have been attacked.

Chorea likewise disqualifies an individual for the army. In youth this is generally a curable affection, but if it resists treatment till the adult age is attained, it is rarely got rid of.

Catalepsy and *paralysis* are also, when present, disqualifying causes for enlistment.

Delirium Tremens.—The fact of an individual having had an attack of this disease does not, we think, unfit him for military service, unless the seizure has been recent, or the causes which induced it still exist. If the attack took place some years previous to the application for enlistment, and the habits of the recruit have in the mean time been good, he should be accepted. On the contrary, if he has had repeated attacks, and indulgence in the use of intoxicating agents still continues, he should be unhesitatingly rejected. We shall return to this subject, and consider it more at length under another head.

Curvature of the spine, either *angular* or *lateral*, indicates constitutional vice or debility, and should lead to rejection.

Organic diseases of the spinal cord absolutely preclude admission into the service.

Neuralgia is perhaps best placed under this head. When severe, it positively unfits the individual for a military life.

THE EYES AND EARS.—These organs should be carefully examined, as on their good condition depends, to a great extent, the efficiency of the soldier.

Paralysis of the upper eyelid or *ptosis* is generally incurable, and incapacitates the individual for service.

Tumors of the eyelids, preventing their closure or of malignant character, ectropion, symblepharon, anchyloblepharon, and *trichiasis* are likewise disqualifying affections.

Disease of the lachrymal gland, occlusion of the puncta

lachrymalia, fistula lachrymalis, or *swelling of the lachrymal sac*, and *occlusion of the lachrymal duct* should reject an applicant for enlistment.

Encanthis, *strabismus*, and *exophthalmia* are disqualifying affections.

Chronic conjunctivitis, *granular conjunctivitis*, *perforation of the cornea*, *procidentia of the iris*, *occlusion of the pupil*, *extensive iritic adhesions*, *staphyloma*, *hypopium*, *cataract*, *glaucoma*, *retinal* or *choroidal disease*, and *amaurosis* should lead to rejection. *Ulcerations of the cornea*, unless extensive and chronic, do not disqualify.

In examining for several of these affections the ophthalmoscope can be very profitably employed. In fact, it is indispensable for the detection of some of them.

Myopia, when excessive, should be regarded as a disqualifying affection. *Nyctalopia* and *Hemeralopia*, when permanent, are also causes for rejection.

Blindness resulting from any cause, in one or both eyes, unfits the man for service.

The diseases of the ear which render a recruit unfit for the army are not very numerous.

The *loss of the external ear*, *hypertrophy of the concha*, or the presence of *malignant*, *erectile*, or *large tumors* of any kind, should be regarded as disqualifying causes.

Obliteration or *stricture of the auditory canal*, *puriform discharge when persistent*, *polypous growths*, *perforation of the tympanum*, *diseases of the Eustachian tube* interfering with the sense of hearing, or *deafness* arising from any cause, lessen the efficiency of the soldier, and are sufficient causes for rejection.

THE NOSE.—*Loss of the nose from violence* or *disease* necessitates rejection. As do also *lipomatous* and *polypous growths*, or *ozæna*, or any *malignant disease*. *Loss of the sense of smell* alone is not sufficient cause for rejection.

THE MOUTH.—*Cancerous*, or *erectile tumors of the lips*,

hare-lip, or *loss of any considerable portion of these organs*, require rejection.

Extensive loss of the teeth, especially of the incisors, or *extensive caries*, and *ulceration*, or *chronic softening of the gums*, necessitate rejection. The importance of these points is, we think, liable to be overlooked. No one can be healthy whose teeth are deficient or in bad condition; and soldiers, of all other classes of men, require that these organs should be sound. The loss of the front teeth prevents the soldier tearing his cartridge, and the loss or carious state of the molars seriously interferes with the proper mastication of his food, and consequently with the digestive process. An unhealthy condition of the gums, besides being of itself a disqualifying cause, indicates a depraved condition of the general system.

Loss of the tongue, or any portion of it, or *hypertrophy of the organ*, require the rejection of the applicant. As do also cancerous or other extensive ulcerations, or adhesions to other parts of the mouth.

Fissure of the palate, elongation of the velum, hypertrophy of the tonsils, when chronic, *stricture of the œsophagus, stammering*, and *dumbness* arising from any cause, also involve the rejection of the recruit.

THE NECK.—*Extensive cicatrices*, causing contraction, such as those produced by *burns, strumous abscesses* or *tumors, torticolis, scirrhus*, or other *chronic swellings* or *tumors, goitre, aneurism, chronic laryngitis*, and *aphonia* are sufficient causes for rejection.

THE CHEST.—*Malformation of the chest, angular* or *lateral curvature of the spine, ulcers*, or *tumors of the thorax* are disqualifying causes for service.

Phthisis, chronic bronchitis, hæmoptysis, organic diseases of the heart or lungs, aneurism of the aorta, and *asthma* render the subject of them unfit for military service.

ABDOMEN.—*Abscess*, or *tumors of the abdominal walls*,

aneurism of the aorta, chronic diseases of the abdominal viscera, and *hernias* of all kinds are sufficient causes for rejection. The number of men entering the army with hernia is very great, and though this affection is not always a cause for discharge from service, it is amply sufficient to warrant rejection.

Hemorrhoids, prolapsus ani, spasmodic contraction, and *fissure of the anus, stricture, cancerous or other tumor of the rectum, fistula ani, artificial anus, malformation of the rectum or anus,* or *chronic irritation and itching of this part* are to be regarded as disqualifying a recruit for service.

THE GENITO-URINARY APPARATUS.—*Hypospadias* and *epispadias, permanent stricture of the urethra, disease of the prostate, calculus, incontinence of urine, vesical tumors, chronic inflammation of the bladder,* as evidenced by the discharge of mucus with the urine, *prurigo,* or *eczema of the scrotum, sarcocele, hydrocele,* or *varicocele, loss of the testicles,* or serious disease of these organs, (absence of one testicle *only,* the other being healthy, is not sufficient cause for rejection,) or *retention of the testicle in the inguinal canal* are causes for refusing to enlist a candidate.

Loss of the penis, cancer, or *indurated chancre* are disqualifying causes for enlistment.

THE UPPER AND LOWER EXTREMITIES.—*Chronic ulcers, cutaneous diseases difficult of cure, extensive cicatrices impeding free motions of the limbs, aneurisms, varicose veins, neuralgia, chronic rheumatism, or its effects, paralysis, contractions, habitual trembling* are sufficient to warrant rejection.

Chronic swellings of the joints of a scrofulous nature, tumors of a malignant character, or even of a benign nature if they impede motion, *necrosis, caries, interarticular cartilages, hydrarthrosis, periostosis, exostosis,* or any malformation of the limbs restraining their free use, such as *club-foot, bandy-legs,* or *knock-knees,* render rejection advisable.

Malformations of the fingers and toes necessitate rejection

if they are of such a character as to interfere with the perfect function of the hands and feet. *Supernumerary fingers and toes* are only cause for rejection under a like condition.

Loss of the index finger of the right hand, of either thumb, or of any two other fingers, is cause for rejection, as is also *loss of the great toe, or of all the other toes.*

THE SKIN.—*Chronic cutaneous diseases* are generally difficult of cure, and demand rejection if they are at all extensive or of a contagious character.

In the foregoing brief enumeration of the disqualifying causes for the enlistment of a recruit, we have only stated the general action which the examining medical officer should take, without going into details. He should be guided by a sound discretion, based upon experience and study. Surgeons, too, should recollect that what may be a cause for refusing to enlist a man is not sufficient cause for discharging from service. In the one case it is necessary to employ curative means to fit him for a new mode of life which may fail altogether; in the other, an attempt should always be made to cure the disease, if it is curable, before proceeding to discharge; for the soldier has, in part at least, learned his duties, and if relieved of his disability would still be capable of rendering effective service.

We have now considered, as far as our limits will allow, the physical pre-requisites of the applicant for enlistment. In the next place we have to treat of those circumstances which affect his health and comfort after his entry into service.

NOTE.—M. Boudin (*Résumé des Dispositions Légales et Réglementaires qui président aux Operations Medicales du Recrutement de la Reforme et de la Retraite dans l'Armée de Terre*) has fully considered the subjects of this chapter, and I have not hesitated to avail myself of the material he has collected.

SECTION II.

OF THE AGENTS INHERENT IN THE ORGANISM WHICH AFFECT THE HYGIENIC CONDITION OF MAN.

CHAPTER I.

RACE.

THE several races of men are distinguished by great differences, so great that they can scarcely be regarded as due to any other cause than a diversity of origin. Climate, hunger, destitution, depravity, disease, exposure, degradation will, in the course of time, work many alterations in the form and aspect of organic beings; but they cannot so alter original types as to cause a race, whether of plants or animals, to lose its identity. Thus, the several varieties of the cabbage are all derived from a wild plant, scarcely edible, growing on the sea-coast rocks of Great Britain. The many kinds of apples all come from a common stock—the crab-apple. The peach, the most luscious of our fruits, has its origin in the bitter almond of Persia. Yet, however much these fruits may have varied from the parent growth, they all evince a tendency to return to the original form when separated from the influences which have given rise to the deviation.

So with the various alterations which animals have undergone, through the action of a changed mode of life, or a different climate, continuing through several genera-

tions. Restore them to their former conditions of existence, and in a short time the original type is reached. Take, for example, the sheep. The fleece of this animal consists of two kinds of wool intermingled: one is formed of coarse, stiff hairs; the other of short, fine, curly wool. In the merino sheep this latter is greatly in excess, and hence the value set upon fabrics made of it; but if the animal is removed to a colder region than is natural to it, the coarse, straight hair takes the place of the softer variety, and the value of the whole growth is lost. Replace the merino sheep in its native climate, and the latter regains its predominance.

The turkey, which is found wild in this country, is of a brownish-black color; by the simple act of domestication it becomes wholly changed in its markings, and is frequently met with entirely white. Yet if allowed to run wild again, the original uniformity of hue is resumed.

Other animals, under like circumstances, become changed in the form of their ears, the shape of their skulls, or the character of their horns; but these variations, like the others we have mentioned, have nothing of permanence about them. They merely exist while the conditions which gave rise to them are in force.

Now, with the several races of mankind the case is altogether different. There are, it is true, certain changes wrought in the physical appearance of man through unfavorable climate and the degenerating influences mentioned. And there are other alterations produced by the action of agents capable of developing his mental and physical organization; but these are quite as transitory in their character as those which ensue in the lower forms of organic beings through like causes, and cannot be held to account for the marked peculiarities which distinguish what are known as the races of men, any more than they will explain the difference which exists between the lion and the tiger, the

horse and the ass, or the Polar bear and his grizzly namesake of the Rocky Mountains.

Place the Caucasian in the tropics of South America, Asia, or Africa, and though his skin may become darker and his hair blacker and coarser, he is nevertheless, though he remain there for hundreds of years, in no danger of being taken for an individual of any other race.

The negro for nearly four hundred years has inhabited America; and yet, except in cases of a mixing of the blood, he presents the same aspect as his progenitors, whose representatives are figured in the monuments of ancient Egypt. And so with the other races; their peculiarities are permanent, and are clearly not due to climate or any other cause than the original impress given to them by the Creator.

It is impossible, in a work of this character, in which the discussion of such questions as the present is merely incidental, to enter at length into the consideration of this subject. Enough has been said to invite the attention of the student to the many interesting points connected with it, and to indicate the belief which the author entertains in the diversity of origin of the several races of men.

The views held by Prof. Agassiz upon this subject appear to be very philosophical, and supported by an array of evidence and probability not capable of being adduced in favor of any other theory. According to this hypothesis, there are distinct centers of creation corresponding to distinct differences existing not only in the fauna, but in the flora of the world. These centers are collected into realms, as Prof. Agassiz designates them. These latter are eight in number: 1st. The ARCTIC, inhabited by *Esquimaux*. 2d. The ASIATIC, inhabited by *Mongols*. 3d. The EUROPEAN, inhabited by *white men*. 4th. The AMERICAN, inhabited by *American Indians*. 5th. The AFRICAN, inhabited by *Nubians, Abyssinians, Foolahs, Negroes, Hottentots,* and *Bosjesmans*. 6th. The EAST INDIAN OR MALAYAN, inhabited by

Telingans, *Malays*, and *Negrillos*. 7th. The AUSTRALIAN, inhabited by *Papuans* and *Australians*. 8th. The POLYNESIAN, inhabited by *South-Sea Islanders*.

There are thus sixteen races of mankind, each race being peculiar to the region in which it dwells, and differing in several important particulars from any other race.

It is not the intention to point out any peculiarities of these several races, except so far as they relate to those with which we are, from association, familiar, and such as have a direct connection with sanitary science. We shall therefore consider only the European, the American, and the Negro.

EUROPEAN RACE.—The conformation of the European is very different from that of any other race. This is especially seen in the size and form of the cranium, the capacity of the chest, the height and shape of the body, and the color of the skin and hair.

Dr. Morton, whose ethnological researches are of so much value, found the mean capacity of the cranium in Europeans to be 92 cubic inches, in the American Indians 79, and in negroes 83 cubic inches. His method of measurement was by filling the skull with small shot, and then emptying these into a graduated measure.

The form of the skull is also of an elevated type. The forehead is high, the face oval, the nose prominent and thin, and the facial angle large, varying from 80° to 85°.

The capacity of the chest is large, and the average height exceeds that of all other races, being almost five feet seven inches for males, and five feet five inches for females.

The form of the body is well marked in several important particulars. The vertebral column is erect, the chest full and rounded, the flanks small, the arms straight, the hands small, the abdomen flat, the lower extremities straight, the calves well developed, and the feet small and well arched.

In the color of the skin the greatest obvious peculiarity

is seen. This is the only race that has a white skin and rosy cheeks.

The color and character of the hair are also worthy of notice. In regard to the former, there is no uniformity, varying from the red hair of the ancient Germans to the black hair, gradually becoming more common. In Germany, Sweden, and Norway light hair is generally met with; while in the southern countries of Europe the black hair greatly predominates.

Besides these morphological characteristics, the European race differs from all others in possessing a greater amount of physical force. It may be accepted as an established fact that the muscular strength is always greatest in those races which are well nourished. The experiments of Peron, on French sailors and natives of Australia and Timor, sufficiently prove this assertion. The results of this observer, corrected by Freycinet, were as follows:—

Individuals observed.	Manual force.	Tractile force.
Frenchmen	155 lbs.	342 lbs.
Australians	117 "	226 "
Malays of Timor	182 "	254½ "

From much observation, I am convinced of the manifest inferiority of the American Indians to the whites in muscular strength.

The capability for resisting the effects of agents prejudicial to health is greater in the European than in any other race. Though the number of diseases to which its members are liable, through the arts and sciences, mode of life, and other influences of civilization by which they are surrounded, is vastly larger, their mental and physical organizations are so much stronger by reason of the many developing and sustaining agencies acting upon them, that morbific forces make much less impression upon them than

upon individuals of other races less highly favored. The exceptions to this rule are not many, and will be pointed out hereafter. Thus, the duration of life is very considerably longer in this race than in any other.

For reasons similar to those above stated, the European is protected, to a greater extent than individuals of other races, against the effects of a climate different from that in which he has been born. He can live and even flourish in the torrid zone, and can pass winter after winter at the north pole, without yielding to the high temperature of the one or the intense cold of the other. The negro, however, if removed from his native climate to one considerably colder, generally perishes, after a short time, from tubercular disease.

Many of the diseases which affect Europeans are due to other causes than the predisposing influence of race. As we have said, civilization has brought with it various pathological influences which act upon them alone, because they only are exposed to them. There is scarcely a disease which occurs in the European, that will not also attack other races if placed within the circle of its action, and generally with much more power.

American Race.—The American Indian is also marked by strong peculiarities of mind and body. Incapable of attaining to a high degree of civilization, he is found in the greatest state of perfection in the forests and plains of the unsettled portions of the American continent. If his mind is cultivated, and the comforts of civilization brought around him, it is always at the expense of his physical organization.

There are great differences to be observed among the several tribes of American Indians. Those of the United States and British America are a well-formed race; tall, straight, and muscular, though neither so tall nor so strong as the whites. In Mexico and South America they are far

less imposing in appearance, and the muscular system is much less developed. The capacity for civilization is, however, greater. The facial angle of the Indian ranges from 75° to 80°.

The American Indian is prone to affections of the respiratory organs to a greater extent than the whites of the same region. Cholera and small-pox are specially fatal to him, and, like many other barbarous nations, he indulges to excess in intoxicating liquors when he can get them. Delirium tremens is, however, entirely unknown among this race.

Every one who has resided among them must have noticed this immunity. Sartorius,* speaking of the Indians of Mexico, says: "The Indian never has delirium tremens, and yet many of them are habitual drinkers—one may even say that they are intoxicated half their lives; while drunkards of the Caucasian race are in a short time irrevocably lost by the poison of alcohol. With nervous fever, however, it is the reverse. The Indian succumbs to this more readily than the white; he neither rages nor becomes delirious, but all energy is wanting, and in a few days he expires of exhaustion."

The same author also declares that the skin of the Indian appears to be less sensitive to heat and cold, and that injuries and wounds heal with much greater rapidity, and are attended with less constitutional disturbance, than in white men.

From the operation of causes which place the American Indians in a position which is unnatural to them, the race is, in the northern parts of North America, rapidly becoming extinct. It appears to be impossible for this race and the Anglo-Saxon portion of the Caucasian race to occupy the same territory at the same time. The weaker type invariably succumbs. On the contrary, in Mexico and other

* Mexico. Landscapes and Popular Sketches. London, 1859, p. 63.

portions of North and South America occupied by inhabitants of Spanish descent, the Indians maintain themselves much better, and though they can scarcely be said to flourish, they are decidedly in a condition far preferable to that belonging to their more northern congeners.

Idiocy and insanity are less frequent than with Europeans. Through exposure and the irregular supply of nutritious food placed at their command, the American Indians rarely attain to an advanced old age.

NEGRO RACE.—The negro of this country, it is to be recollected, is living in a climate which is altogether foreign to him. As he is not gifted with the adaptativeness which the European possesses, he is seen under somewhat adverse circumstances, so far as his hygienic condition is concerned.

In his native regions, the negro lives in the very lowest depths of barbarism, and it is here that we should look for a typical representative. So far as his mental and physical characteristics are concerned, it is very doubtful if any positive advance has been made by transferring him to civilization. The negro of unmixed blood presents the same prognathous skull, the facial angle of which measures from 70° to 75°; the same short, coarse, frizzled hair; the same dark skin and cast of features. The arms are long, the lower limbs crooked, the calf meager, the os calcis prolonged posteriorly, and the foot lacking the high arch which characterizes this member in the European.

It is not to be denied, however, that the negro is capable of considerable intellectual and physical development, though it seems, nevertheless, that he is altogether incapable of attaining to the highest point in either. By transferring him to a temperate climate, he has positively lost rank physically. The proper place to make the experiment of civilization with him is in the climate under which he has lived for thousands of years. Brought to one such as that of the United States, he becomes tuberculous just

as do the lions, tigers, and monkeys which are transported out of their native lands.

Negroes in temperate climates are extremely liable to phthisis and other scrofulous diseases. They are incapable of resisting cold weather, and suffer exceedingly from chilblains and other affections depending on a languid circulation. Ulcers heal with difficulty, and chronic abscesses are comparatively frequent with them.

In regard to the predisposition to phthisis, the statistics of the British army are very conclusive. In the West India islands and other British colonies, regiments of negro troops are maintained in considerable proportion. The following table shows the number of white and negro troops, per thousand, dying annually of phthisis:—

	White troops.	Negro troops.
Jamaica	7·5	10·3
Bahamas	6·0	9·7
Honduras	3·0	8·1
Sierra Leone	6·0	6·3
Mauritius	4·0	12·9
Ceylon	4·9	10·5
Gibraltar	5·3	43·0

We see the effects of climate very decidedly shown from an examination of this table. In Sierra Leone, the climate of which is natural to the negro, his mortality from phthisis is not essentially greater than that of the white troops associated with him, while at Gibraltar it is more than eight times greater.

But if the negro is more susceptible than the white man to the diseases mentioned, he possesses a greater immunity against others. It is a well-ascertained fact that he is much less liable to affections of malarious origin than the European. He is enabled to work in the rice and cotton fields of the Southern States with impunity, and yellow fever rarely attacks him.

The following table shows how much greater the mortality from malarial fevers was among white than negro troops, during the period extending from 1817 to 1836, in the colonies specified:—

	English.	Negroes.
Jamaica	101·9	8·2
Bahamas	159·0	5·6
Honduras	81·0	4·4
Sierra Leone	410·0	2·4
Mauritius	1·7	0·0
Ceylon	24·6	1·1

The negro is also less susceptible to the influence of the syphilitic poison than the white race. I have had many opportunities of observing how rapidly soft chancres heal in them, and how lightly and transiently they are affected by secondary manifestations. Livingstone* asserts that the negroes of the southwestern part of Africa recover from all venereal diseases without any treatment whatever, and that it appears to be impossible to perpetuate syphilis among them.

Tetanus would seem to be much more common among negroes than whites, and that singular disease called yaws is almost peculiar to them.

On the other hand again, they are less subject to nervous diseases, and bear pain with greater fortitude than the more finely organized white race.

Negroes are not able to resist low temperatures as well as the superior races, while, on the contrary, they bear extreme heat much better.

The American government does not permit the enlistment of negroes in its armies. The English, French, Spanish, and Danish governments maintain black troops in quite large numbers. They are, however, much less capa-

* Missionary Travels. London, 1858, p. 128.

ble of enduring fatigue than white troops, though for certain kinds of service, as for instance in marshy and malarious regions, they might be employed to advantage. As teamsters they are certainly valuable, and, perhaps, might be made available as nurses in hospitals. Most of the cooks in service in the hospitals in Washington City are negroes.*

In regard to other races than those we have specially referred to, a great many interesting facts are on record. For instance, Dr. Ewart† shows that the sickness and mortality among the European troops serving in India are very much greater than in the native troops. Dysentery, cholera, malarial diseases, and even phthisis, being far more common among the English soldiers than the Sepoys. But this predisposition on the one part and immunity on the other are not to be regarded as due so much to the influence of race as that of climate, and therefore will be more appropriately considered under another head.

In a very interesting memoir, Boudin‡ treats of the in-

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* Since the foregoing was written, I have received a copy of the "Statistical, Sanitary, and Medical Reports" of the British Army for 1860. From this it appears that the proportion, per thousand, dying of tubercular diseases in 1860, in the troops stationed in the West Indies, was, for the white troops, 4·75, and the black troops, 7·63. The following table also gives interesting results:—

		White troops.	Black troops.
Ratio, per thousand, constantly sick..	1860...	30·98	47·98
	1859...	53·73	54·90
		Days.	Days.
Mean sick time to each soldier.........	1860...	11·30	16·33
	1859...	19·61	20·03
Average duration of the cases..........	1860...	11·91	18·29
	1859...	15·92	17·17

† A Digest of the Vital Statistics of the European and Native Armies in India. London, 1859.

‡ Essai de Pathologie Ethnique, etc., Ann. d'Hygiène, deuxième série, tome xvi. p. 8, and tome xvii. p. 64.

fluence of race in causing disease, and among other points considers the question of the immunity of certain races to the poison of serpents.

The history of the Psylles is so enveloped in fable that it is difficult to get at the truth of the stories which ascribe to them an exemption from the injurious results which ordinarily follow the bite of poisonous serpents. From what we know, however, relative to this immunity in modern times, it may, we think, be assumed that there is nothing impossible in so much of the tradition as ascribes to this people a marked indisposition to be injured by the poison of serpents.

There would appear to be little doubt that the Aïssaoua (a people inhabiting the northern part of Africa) can receive wounds from poisonous serpents without material injury. Boudin quotes from Lempriere, Berbruger, and Bellemarre some very singular statements in regard to this point, and, without affirming the existence of any such immunity as that claimed by the above-named travelers for the Aïssaoua, thinks the evidence in support of it is of such a character as not to be disregarded.

As the result of my own observations, I am satisfied that the North American Indians can receive the venom of the rattlesnake into their blood without being subject to the morbid phenomena to which the whites are liable from a like injury.

In addition to the influence of race over the production of disease, we find that there are great differences among nations in this particular, and that even parts of nations exhibit peculiarities in this respect. As it is probable that the influence of climate, soil, and other causes than those of an ethnological character, are the main agents at work in producing the susceptibility to some diseases and immunity to others to which we have referred, it will be more advisable to consider them under other heads.

Certain races of men have improved their condition; others, on the contrary, have degenerated. We have seen that under the influence of cultivation, plants which are comparatively worthless are developed into flourishing and esculent vegetables. By processes well understood, domestic animals are rendered larger, stronger, and more prolific; and others are taken from their natural wild state and converted into docile and useful servants of man, or their tissues are so modified by proper treatment that they become valuable as food.

Numerous examples of the improvement of races have been furnished by the history of the world. No one can doubt the beneficial effects to the effete inhabitants of Italy from the irruption of the northern hordes of Europe into that country, or the character of the reaction which these barbarians themselves received from the intermingling of blood and the genial influence of a more benign climate than that they left behind them. Take also the example of England; first conquered by the Romans, then overrun by the Danes and Saxons, then entirely subdued by the Normans. Each infusion of new blood formed an era of progress, morally, intellectually, and physically. The conquest of Spain by the Moors is another instance; arts flourished, sciences were developed, literature was strengthened. The conquerors were in their turn subdued and expelled; had they retained their foothold, Spain at the present day would have been worthy of them.

In the United States we have the most striking example of all. Who can doubt that the activity both of mind and body, the ceaseless energy, the superb physical development of the people, are due to the commingling of the blood of all the nations of Europe? To be an American is to be a cosmopolitan.

Now, there are several other influences to be regarded. In order that men should develop, the climate must be

favorable, the food of good quality and easily obtained, the clothing sufficient, and the mind kept actively engaged; but the most active of all causes is that we have alluded to—the intermixture of blood.

But one race cannot improve another race in this manner. All the examples we have cited are instances of the engrafting of one or more nations on one or more other nations of the same race. Thus, the Goths, the Vandals, and the Huns* were of the same ethnological realm as the nations of the south of Europe whom they conquered; the Romans, the Saxons, the Danes, and the Normans were of the same race as the islanders they subdued; the Moors were as white and as thoroughly Caucasian as the Spaniards themselves; and the American is the resultant of numerous nations of the same race. A mixture of the blood of different nations of the same race is better than either of the parent stocks. Those nations are furthest advanced intellectually and physically which are most thoroughly composite in their character.

When one race mingles with another, a tendency to degeneration at once manifests itself; and if the races are very diverse, this tendency is shown in a marked degree. We see this law strikingly manifested in the offspring of the whites and Indians, and still more so in the mulatto. Half-breed Indians are scarcely ever as robust as either of the races from which they came, and do not possess in the highest degree the power of procreating the species. Mulattoes are almost invariably weak and tuberculous, and possess very little power of procreation. It is generally the case that the children of parents, both mulattoes, are sterile.

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* I am aware that I lay myself open to criticism in asserting the Huns to be of the same race as the Goths, Vandals, and other European nations. The testimony is, however, to my mind perfectly clear on the subject.

In the United States the whites and Indians have not mixed to any very great extent; but in Mexico and South America the case is different. In the United States the whites swept the natives of the country before them. The Spaniards, on the other hand, endeavored to civilize them. In the one case they became extinct; in the other, degraded.

With reference to the adaptability of races to a military life, many points of great interest might be brought forward. No doubt, however, can exist relative to the great superiority of the Caucasian or European race for all the purposes of war. In endurance, in strength, in courage, in intelligence, in susceptibility to discipline, in a knowledge of the art of war, and of the arts and sciences applicable to war, this race is pre-eminent, and has always, when occasion required, made its superiority apparent.

The American army is composed entirely of Caucasians. Indians and negroes are not allowed to enter it except as laborers or servants. The former have occasionally been employed as irregular troops against the more barbarous tribes, but no very decisive result has ever attended their use. As guides and scouts they have often proven to be excellent auxiliaries. They are altogether incapable of being brought under military discipline.

The negro, on the contrary, is very readily made to submit to the constraints imposed by military law. He is docile, and, as the experience of other nations has shown, is adapted to certain kinds of service.

NOTE.—Since the above was written, negro regiments have been incorporated into the army. It is probable the experiment will soon be tried on a larger scale, with what success remains to be seen.

CHAPTER II.

TEMPERAMENTS IN GENERAL.

THE ancients laid very great stress on the doctrine of temperaments, and on the influence which these conditions of the system were capable of exercising over diseases. Galen arranged them into four classes, corresponding, as he supposed, to four different liquids of the body, which, in their turn, represented the four elements. These four humors were the bile, the blood, the black bile, and the lymph; and hence he had the bilious, the sanguineous, the atrabilious, and the lymphatic or phlegmatic temperaments, according to the predominance of one or other of these fluids.

We know, however, that no such connection as that supposed by Galen really exists, yet the names given by him are still those which are in vogue. The individual of sanguineous temperament has no more blood than the one of phlegmatic temperament, nor less lymph; neither can these fluids be supposed at all to influence mental constitution or physical peculiarities. The same remarks may be applied to the bile, so that there is no necessary or direct connection like that assumed by Galen.

But there can be no doubt in regard to the existence of certain mental and physical types which present certain distinct characteristics easily recognizable, so that from an inspection of the aspect and general physical construction of a man we are enabled to define with tolerable certainty his psychical peculiarities. These types we call temperaments.

Müller defines temperament as a peculiar permanent condition, or mode of mutual reaction of the mind and

organism. I cannot say that the definition is a very clear or satisfactory one, although perhaps sufficient to indicate the idea intended to be expressed.

Temperament is rather the organic constitution dependent upon certain mental and physical peculiarities, innate or acquired. It is the specific difference which gives to persons, or groups of persons, their individuality. We can very readily conceive that it must influence very materially the predisposition to disease. And in fact when we come to consider the subject in all its bearings and with the profundity of which it is worthy, we find it very difficult, if not impossible, to distinguish between temperament and predisposition. And as we can indicate the intellectual character of the individual from the color of his hair and complexion, the size of his hands and feet, or the peculiarities of his pulse and respiration, we are enabled with as much certainty to designate the diseases to which he is specially liable from a similar examination.

It is not, however, to be asserted that the temperaments are separated from each other by strictly defined lines. If they were, we should probably have more uniformity among authors in their classification. As it is, a very considerable diversity exists, some making but two, and others as high as seven. It is very much with the temperaments as it is with the colors of the solar spectrum: they overlap each other and give rise to certain compound temperaments which possess many of the characteristic marks of distinct conditions, but which may, without much difficulty, be separated into their original constituents.

Cullen was able to see but two temperaments, the *sanguineous* and the *choleric;* all others he regarded as combinations of these two. Bégin, with more propriety, recognizes three: the sanguineous, the lymphatic, and the nervous. I agree with several authors in admitting four: the sanguineous, the lymphatic or phlegmatic, the choleric,

and the nervous. This division is that adopted by Devay,* and one which appears to be founded on original differences.

The study of the temperaments is, we fear, too much neglected at this day by physicians, and in the selection of recruits altogether ignored. I do not intend to be understood as implying that a recruit should be rejected, no matter what may be his temperament, if he is otherwise fit to perform the duties of a soldier, but he might be rendered of far greater service to the country by assigning him to that arm of the service the character of which corresponds to his psychical and bodily peculiarities as indicated by his temperament. In the following remarks on the particular temperaments, I shall again draw attention to this point.

In examining a patient, as a rule very little attention is paid to the study of the temperament, although from this source a flood of light can always be obtained to assist in determining the diagnosis, the prognosis, and the treatment. In seeking to ascertain the particular temperament of an individual, it is necessary to take into consideration not only his physical peculiarities, but also the mental characteristics he may possess.

"Thus, when it is desirable to acquire valuable information in regard to the temperament of any one, in order to treat him pathologically or hygienically, it is necessary to refer to some person acquainted with his physiological history. It is necessary to forget every preconceived idea relative to the divisions and categories established by authors, in order to fix the mind on the birth, the former diseases, the habits, the existing state of the solids and liquids relative to the forces, that is to say, the combination of movements which animate the organism—the tendency, the genius of the passions. There is not one of

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* Traité Special d'Hygiène des Familles, etc. Paris, 1858.

these things that does not act upon the temperament, not one to which it may not be tributary. It is only after having decomposed by analysis all the parts which constitute the edifice called the human organization, that it can be reconstructed so as to present to the view the impress due to constitution and temperament. And as all these circumstances vary in each individual, so that each has his own peculiar manner of feeling and moving, the variety of temperaments is incalculable. It will be always impossible to assign them to precise classes."*

CHAPTER III.

PARTICULAR TEMPERAMENTS.

THE SANGUINE TEMPERAMENT.—This temperament is characterized by great activity of the circulatory and respiratory apparatus, and by great vivacity of the mind. The pulse is quick, strong, and bounding; the complexion florid; the hair red or chestnut color; the eyes blue; the hands and feet small; the skin thin and fair; the respiration active; the digestion good; the excretion from the skin abundant, while, owing to this latter cause, the urine is found in small quantity and is high colored. The powers of endurance are very considerable, though not so great as in the choleric temperament, not so much from any physical defects as from mental peculiarities. The expression of

* Devay, op. cit. p. 72.

countenance is cheerful and hopeful, and activity characterizes all the movements.

In the mental constitution we see the same qualities displayed, modified, of course, by the different material with which they are associated. There is the same restlessness and brilliancy, and while any particular bent is followed a good deal of energy is shown. The love of pleasure predominates, but the pleasure must be frequently varied or satiety is produced. Inconstancy is the predominating influence. Good resolutions are formed but to be broken. Friendships are contracted to be soon abandoned for others, which in their turn are given up. In love the individual of sanguine temperament is fickle and faithless, and cares less for his honor than his pleasure. He engages in great undertakings without counting the cost, and if difficulties not estimated for appear, he soon becomes discouraged, unless he sees an ultimate advantage to himself from persevering. If success attends his efforts, as it often does, it is more on account of the rapidity of his actions than the consequence of any well-laid plans, or else the result of that "good luck" of which he is frequently the recipient.

History furnishes many examples of distinguished persons of sanguine temperament. Marc Antony and Plato among the ancients; Charles II. of England, Lorenzo di Medici, the Duke of Richelieu, and Murat, are instances of it. In this country General Wayne was a good example of this temperament. Shakspeare, in his inimitable character of Mercutio, has depicted it with masterly power. Poetry, painting, and sculpture have their most distinguished cultivators among individuals of the sanguine temperament.

Temperate climates afford the most striking instances of this form of temperament. We see this not only in the physical characteristics of individuals, but in the history of the nations which inhabit these regions.

The female sex contains more representatives of it than the male, and youth more than adult or old age.

The diseases to which those of the sanguine temperament are peculiarly disposed are those connected with the circulatory system. Thus they are liable to functional and organic diseases of the heart, aneurism, and hemorrhages. Contrary to the generally expressed opinion, I do not believe in any decided proclivity of individuals of this temperament to inflammatory affections. Activity of circulation is not favorable to diseases of this character.

Epidemic and malarious diseases appear to attack persons of the sanguine temperament with more readiness than others. This may be due to the recklessness of such individuals, which prevents them taking the ordinary precautions to preserve health. For the same reason it is, perhaps, that venereal diseases are so much more commonly met with in them.

At the same time I am of the opinion that there is an excessive degree of impressibility, which renders the possessors of this temperament extremely liable to certain zymotic diseases. I have had many opportunities of verifying this assertion. It is one which, if confirmed by further experience, cannot but be of importance.

With reference to the adaptability of individuals, according to their temperaments, to the requirements of a military life, little has been written, though it is a question which, in many respects, is of great interest. Physically, persons of the sanguine temperament are equal, ordinarily, to any trial which can be demanded of them. By exercise of the muscles they become well developed and hard, and that peculiar modification of the organism known as the athletic is produced. But the qualities of the mind are also to be considered. The enthusiasm, the activity, the "dash," which individuals of sanguine temperament possess, pre-eminently qualify them for the cavalry arm of the service. Here

they have peculiar opportunities for the display of those qualities which are inseparable from them, and which are so essential to good cavalry soldiers. Next to the cavalry, they are better placed in the light artillery, and next in the light infantry. They are not the best men for the heavy infantry or heavy artillery. They are better at making a charge than in resisting one.

Soldiers of sanguine temperament are valuable as tending to keep up the spirits of their comrades, for they are hopeful, and generally look upon troubles and hardships with but little seriousness.

THE LYMPHATIC OR PHLEGMATIC TEMPERAMENT.—This temperament is the direct opposite of the sanguine in almost every respect. The flesh is flabby and soft; the pulse weak and languid; the respiration slow; the countenance pale or leaden color; the eyes green or pale gray, and expressionless; the hair dry and light colored. The whole form is rounded, and lacking in that elasticity which characterizes the sanguine temperament.

Mentally the difference is equally striking. All the emotions of the mind are slow and indecisive, and rarely, if ever, of a high or energetic character. The memory is weak, and the powers of application or of fixing the attention inconsiderable. There is therefore a disinclination to reflection, study, or any mental or physical exertion. Men of this temperament have made but little sensation in the world's history. The part they have played has been quiet, unobtrusive, and even insignificant.

But it is not to be supposed that this temperament has not its good side. Although prompting to slowness, there is often a perseverance which may compensate for a want of rapidity. Friendships are not often contracted, but when once formed are frequently enduring. Great undertakings are rarely attempted, but those moderate ones which constitute the bulk of the operations of every-day

life, and which require neither brilliancy nor energy, are accomplished without bustle or confusion.

As Müller remarks, the subject of the phlegmatic temperament may be a very useful and trustworthy member of society. "When rapid action is required, the phlegmatic person is less successful, and others leave him behind; but where no haste is necessary and delay is admissible, he quietly attains his end, while others have committed error upon error, and have been diverted from their course by their passions. The phlegmatic person knows his proper sphere, and does not trespass upon that of others, or come into collision with them. From this conduct, as well as from an orderly and steady course of action, in which he keeps his object in view and avoids self-deception, he derives a contented tone of mind, free alike from turbulent enjoyments and deep suffering."*

Cold and damp climates are those in which this temperament is most generally met with.

Old age more frequently exhibits it than youth.

The diseases to which those of lymphatic temperament are especially predisposed are such as are due to weakness and relaxation of the tissues, together with feebleness of the circulation. Thus inflammations—particularly those of a low and chronic character, attacking in preference the mucous membranes—are frequently encountered in subjects with this temperament. Scrofulous affections, such as degeneration of the lymphatic glands, tuberculous inflammations of the joints, tuberculous deposits in the lungs, and skin diseases, are common, as are also dropsical affections.

As far as my observation extends, individuals of lymphatic temperament are not especially liable to malarious diseases, or to be the subjects of epidemic or contagious diseases, with the exception of influenza, to which they appear to be particularly disposed when it is prevailing.

* Elements of Physiology, edited by Dr. William Baly, vol. ii. p. 1408.

The lymphatic temperament is not that which should predominate in soldiers. Certain combinations of it, to which we shall hereafter allude, do very well, but when it is of the pure type it ill comports with the qualities which a soldier should possess. Men of this organization are better in the heavy artillery arm of service than in any other arm. For the cavalry arm of service, or any other in which daring and *elan* are required, they are not suited.

THE CHOLERIC OR BILIOUS TEMPERAMENT.—The physical and mental characteristics of this temperament are exceedingly well marked. The complexion is dark or sallow; the hair black or a dark brown; the eyes black or hazel; the skin dry and not over soft; the flesh hard and firm; the pulse strong, hard, and frequent; the respiratión deep and strong, and the whole form thin, tough, and wiry.

Mentally the man of choleric temperament is characterized by firmness, decision, and determination. His mind is quick and active; his perseverance carries him over all difficulties. He is irritable, sensitive, and often vindictive and cruel. "Bold in the conception of a project, constant and indefatigable in its execution, it is among men of this temperament we find those who, in different ages, have governed the destinies of the world; full of courage, boldness, and activity, all have signalized themselves by great virtues or great crimes, and have been the terror or admiration of the universe. Such were Alexander and Julius Cæsar, Brutus, Mahomet, Charles XII., the Czar Peter, Cromwell, Sixtus V., Cardinal Richelieu.

"As love is in the sanguine, so ambition is in the bilious, the governing passion. Observe a man who, born of an obscure family, long vegetates in the lower ranks. Great shocks agitate and overthrow empires; at first a secondary actor in those great revolutions which are to change his destiny, the ambitious man hides his designs from all, and by degrees raises himself to the sovereign power, employ-

ing, to preserve it, the same address with which he raised himself to it. This is, in few words, the history of Cromwell, and of all usurpers.

"To attain to results of such importance, the profoundest dissimulation and the most obstinate constancy are equally necessary; these are, further, the most eminent qualities of the bilious. No one ever combined them in higher perfection than that famous pope who, slowly traveling on toward the pontificate, went for twenty years stooping, and talking forever of his approaching death, and who, at once proudly rearing himself, cries out, 'I am pope!' petrifying with astonishment and mortification those whom his artifice had deceived into his party.

"Such, too, was Cardinal Richelieu, who raised himself to a rank so near to the highest, and was able to maintain himself in it: feared by a king whose authority he established; hated by the great, whose power he destroyed; haughty and implacable toward his enemies, ambitious of every sort of glory, etc.

"The historians of the time inform us that this celebrated minister showed all the customary signs of the bilious temperament. Gourville tells us he was all his life subject to a very troublesome hemorrhoidal discharge."*

The choleric temperament is more frequently encountered in the inhabitants of the warmer portions of the temperate zone than in other localities.

The diseases to which individuals of the choleric temperament are particularly predisposed are those connected with the liver and other organs of digestion. They are, of all others, especially liable to malarious affections, such as the various forms of intermittent and remittent fevers, typhoid fever and dysentery; dyspepsia and internal congestions often attack them, and hemorrhoids are not infrequent.

* Richerand's Elements of Physiology, edited by Dr. Copeland. Am. ed., p. 370.

Both mentally and physically the individual of choleric temperament is admirably qualified for military service. His obstinacy and energy are qualities which cannot be overestimated. As we have seen, some of the most celebrated soldiers of the world have been of this temperament, and the list might readily be extended.

THE NERVOUS TEMPERAMENT.—In this temperament the manifestations of nervous action give an impress to the whole body. The countenance is usually pale, and the features thin and sharp; the pulse is quick, small, and frequent; the respiration active; the chest not largely developed; the skin dry and rough, and the digestive functions performed irregularly. The urine is generally copious and of pale color.

As the muscular system is not fully developed, persons of this temperament easily become fatigued.

The intellectual operations of those of the nervous temperament are rapid and brilliant, but, at the same time, not often persistent. Variety is constantly sought for; the mental efforts, like the physical, are, as it were, spasmodic, full of energy while they continue, but soon yielding to others.

Women are much more frequently the subjects of this temperament than men. It is often acquired by habit of thought or mode of life, and is seldom met with among barbarous nations, the whole spirit of civilized institutions predisposing to its formation.

Voltaire, and Frederick the Great of Prussia, are notable examples of the nervous temperament. John Randolph, perhaps, affords the most remarkable example of it among distinguished Americans.

The diseases which are most apt to occur among individuals of the nervous temperament are those having an intimate relation with the nervous system. Thus we have chorea, hysteria, catalepsy, monomania, and mania. In

fact, the nervous temperament itself is almost a pathological condition. The sensibility is so acute, and the system so readily thrown into disorder from slight causes, that the temperament in question may well be considered as the first manifestation of disease.

Individuals of strongly-marked nervous temperament are altogether unsuited to engage in a military life. The want of development in the muscular system, together with the great preponderance of the nervous organization, tend too much to the conditions above mentioned. With the best intentions in the world, they are not to be relied on. I have seen several well-marked cases among officers and men of the army, and am cognizant of not a few ludicrous events, or rather what would have been ludicrous but for the consequences, which, however, were of a more serious character.

As has been said, it rarely if ever happens that the temperaments are so clearly marked that any one individual can be said to possess the traits of one without being endowed with several attributes of some other. Thus, there are the sanguineo-lymphatic, the sanguineo-choleric, the sanguineo-nervous, and so on. Each of these conjoins in itself the manifestations of the temperaments of which it is composed in an equal, or nearly equal, degree, or the traits of one may very decidedly predominate, in which case it is named accordingly.

In addition, there are certain conditions which are degenerations of the temperaments. Thus there is the plethoric state founded upon the sanguineous, the obese on the lymphatic, and the melancholic on the choleric. These conditions may properly be considered as positive diseases, and as such calling for medical intervention.

CHAPTER IV.

IDIOSYNCRASY.

By idiosyncrasy we understand a peculiarity of constitution by which an individual is affected by external agents in a manner different from mankind in general. Thus some persons cannot eat strawberries without a kind of urticaria appearing over the body, others are similarly afflicted by eating the striped bass, others again faint at the odor of certain flowers, and some are attacked with cholera morbus after eating certain shell-fish. Many other instances might be adduced, some of them of a very curious character. These several conditions are called idiosyncrasies.

M. Bégin, who defines idiosyncrasy as due to the predominance of an organ, of a viscus, or a system of organs, has hardly, I think, fully grasped the subject. It is something more than this; something inherent in the organization of the individual, of which we only see the manifestation when the proper cause is set in action. We cannot attempt to explain why one person should be severely mercurialized by one grain of blue mass and another take daily ten times this quantity for a week without the least sign of the peculiar action of mercury being produced. We only know that such is the fact, and were we to search for the cause with all the appliances which modern science could bring to our aid, we should be entirely unsuccessful. According to Bégin's idea, we should expect to see some remarkable development of the absorbent system in the one case, with slight development in the other; but even were such the case it would not explain the phenomena, for when ten grains of the preparation in question are taken daily,

scarcely a day elapses before mercury can be detected in the secretions, and yet hydrargism is not produced, while when one grain is taken and this condition follows, the most delicate chemical examination fails to discover mercury in any of the fluids or tissues of the body.

Bégin's definition scarcely separates idiosyncrasy from temperament, whereas, according to what would appear to be sound reasoning, based upon an enlarged idea of the physiology of the subject, a very material difference exists. Persons may be alike in temperament, but there never were two individuals with the same or even similar idiosyncrasies.

Idiosyncrasies are often hereditary and often acquired. Two or more may exist in one person. Thus there may be an idiosyncrasy connected with the digestive system and another with the circulatory system.

An idiosyncrasy may be of so important a nature as to altogether unfit an individual for the duties of a soldier, or it may be of an entirely insignificant character. By perseverance some idiosyncrasies may be completely overcome. I knew a gentleman who could not eat soft crabs without experiencing an attack of diarrhœa. As he was exceedingly fond of them he persevered in eating them, and, after a long struggle, succeeded in conquering the difficulty.

Individuals with idiosyncrasies soon find out their peculiarities, and are enabled to guard against any injurious results to which they would otherwise be subjected but for the teachings of experience.

Idiosyncrasies may be temporary only, that is, due to an existing condition of the organism, which, though natural or morbid, is of a transitory character. Such, for instance, are those due to dentition, the commencement or cessation of the menstrual function, pregnancy, etc. These are frequently of a serious character, and require careful watching; but when the condition which has given rise to them has

passed away, the idiosyncrasy generally, but not always, likewise disappears.

Some conditions, often called idiosyncrasies, appear to be, and doubtless are, due to disordered intellect. But they should not be confounded with those which are inherent in individuals aside from mental derangement. Frequently they are merely imaginary, there being no foundation for them except in the perverted mind of the subject; at other times they are induced by a morbid attention being directed continually to some one or more organs or functions. Thus the protean forms under which hypochondria manifests itself are rather due to the reaction ensuing between mental disorder on the one part and functional disorder on the other, than to that *quasi* normal peculiarity of organization recognized as idiosyncrasy.

The idiosyncrasies of individuals are not matters for ridicule, however whimsical they may be; on the contrary, they deserve and should receive the careful consideration of the physician, for much is to be learned from them both in preventing and treating disease.

CHAPTER V.

AGE.

TIME, which exercises its influence even upon inorganic bodies, is immeasurably more powerful in its relations with organized beings. They spring into existence, increase, decay, and die, according to the laws of their being. In some the cycle is completed in a few days, in others in a few years, and in others again not until centuries have

elapsed. This is true equally of animals and plants. The moth of the silk-worm, and certain species of cryptogamic plants measure the period of their existence by hours, while the alligator and the oak count hundreds of years of life.

The length of human life is fixed by the Scriptures at fourscore years as a maximum. Flourens believes the natural life of man to be one hundred years, and adduces many ingenious arguments in support of his opinion. Instances are not wanting in which even this limit is greatly exceeded.

During life the fluids and tissues of the body are constantly undergoing change. New matter is deposited, and the old is removed with ceaseless activity. The body may be regarded as a complex machine, in which the law that force is only generated by decomposition is fully carried out. Every motion of the body, every pulsation of the heart, every thought which emanates from the encephalon, is accompanied by the destruction of a certain amount of tissue. As long as food is supplied in abundance and the assimilative functions are not disordered, reparation proceeds as rapidly as decay, and life is the result; but should nutrition be arrested by any cause for any considerable period, new matter ceases to be formed, and the organs, worn out, act no longer, and death ensues.

The animal body differs from any inorganic machine in the fact that it possesses the power of self-repair. In the steam-engine, for instance, the fuel which serves for the production of steam, and, subsequently, for the creation of force, can do nothing toward the repair of the parts which have become worn out by use. Day by day, by constant attrition and other causes, the engine becomes less perfect, and eventually must be put in order by the workman. In the animal body, however, the material which serves for the production of force is the body itself, and the substances which are taken as food are assimilated, according

to their character, by those organs and parts which require them.

The body is therefore undergoing continual change. The hair of yesterday is not the hair of to-day; the muscle which extends the arm is not identically the same muscle after as before its action; old material has been removed and new has been deposited to an equal extent; and though the weight and form, the chemical constitution, and histological characters have been preserved, the identity has been lost.

So long as these two actions exactly counterbalance each other life continues. If it were possible so to adjust the repair to the waste that neither would be in excess, there is no physiological reason why life, if protected against accidents, should not continue indefinitely. But this is not, with our present knowledge, possible, and consequently decomposition eventually becomes predominant, and death from old age results.

The life of man has been variously divided, by different authors, into artificial periods or stages, the limits of which are by no means accurately marked. Thus Haller made five periods: 1st, *first infancy*, extending from birth to the 7th year; 2d, *second infancy*, from the 7th to the 13th or 15th year; 3d, *puberty*, extending in females from the 13th to the 21st year, and in males from the 15th to the 25th year; 4th, *virility*, lasting in women from the 21st to the 50th year, and in men from the 25th to the 60th year; and 5th, *old age*, which extends from the 60th year to death.

Richerand divides the life of man into four stages: *infancy*, *puberty*, *manhood*, and *old age*. Daubenton makes six divisions: *infancy*, extending from birth to the period of puberty; *adolescence*, from puberty to the 20th or 25th year; *youth*, which embraces the period between the 25th to the 30th or 35th year; the *age of virility*, which extends to the 40th or 45th year; the *age of decline*, which lasts to

the 60th or 65th year; and *old age*, which terminates in death.

All these divisions are purely artificial, and marked by no well-defined boundaries. A natural division, which is based upon the physiological course of the life of man, is not only more convenient but more correct. In accordance with this principle therefore I should divide the life of man into three periods: 1st, the *period of increase*, in which the formation of tissue predominates over decay; this stage extends from birth to about the 25th year, varying according to individual and sexual peculiarities; 2d, the *period of maturity*, in which the processes of regeneration and waste are counterbalanced, extending from the 25th year or thereabouts to the 35th year; 3d, *the period of decay*, in which the tissues are not regenerated as fast as they are broken down and excreted from the system, and reaching from the 35th year to the extreme limit of human life.* We shall find that each of these stages is marked by strong peculiarities, both of organization and action, and that they exhibit immunities to some diseases and susceptibilities to others which are only to be accounted for by a reference to the physiological condition by which each stage is characterized.

THE PERIOD OF INCREASE.—The average height of the human subject at birth is between eighteen and nineteen inches, and the weight about seven pounds. The bones are not yet completely ossified, the muscles are soft, the skin thin and highly vascular, and the circulatory and nervous systems developed to a much greater comparative extent than at any other period of life. The development of the height and weight with reference to the age of the individual have already been considered, and need not therefore detain us now.

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* This division, which is as old as Aristotle, is preferable to any which has been since devised.

A great tendency exists, during the first five years of the period of increase, to diseases of the nervous system, and this is at its maximum during the first dentition. Convulsions due to irritation, and inflammation of the brain and its membranes, are, accordingly, of common occurrence. Affections of the digestive system, induced also by the excessive irritability of the nervous system, are also frequently met with at this time.

The respiratory system in very young children exhibits likewise a strong proclivity to inflammatory diseases. Pneumonia and bronchitis are readily induced by exposure to very slight changes of temperature. Croup is pre-eminently a disease of early childhood, the tendency to it decreasing after the second year, at which period it is greatest.

Villermé,* quoting from M. Duvillard, and referring to the epidemic in Copenhagen in 1825, shows that small-pox is more frequently fatal to the young than the adult. The former he also states to be more susceptible to malarious influences. Scarlet fever, measles, hooping-cough, mumps, and other contagious diseases, are far more liable to attack children than adults.

Malgaigne† found by calculation that hernia occurred much more frequently with the young than with the middle-aged or old. This is doubtless correct, and is readily explained by the fact that the inguinal canal is relatively larger in youth than in adult age. Umbilical hernia is almost entirely a disease of early infancy.

Quetelet‡ has shown that one-tenth of all the children born, die during the first month of existence, and that at the termination of the first year after birth, one-fourth have

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* Des Épidémics, etc. Annales d'Hygiène, 1833, tome ix. p. 31.

† Recherches sur la Frequence des Hernies, selon les Sexes, les Ages, et relativement a la Population. Ann. d'Hygiène, 1840, tome xxiv. p. 33.

‡ A Treatise on Man and the Development of his Faculties. Edinburgh, 1842, (English translation.)

died. So great is the mortality that at the fifth year, of 10,000 boys born in towns, but 5738 remain alive. Nearly one-half have died.

Herrmann* states that in Russia the mortality of infants is greater than that of all other ages put together.

According to Villermé 22 per cent. of the total number of deaths occurring in Paris, from 1817 to 1825 inclusive, were in infants under one year old, and 44·5 per cent. in children under ten years of age.

Mallet† states that in Geneva, from 1814 to 1833 inclusive, 151 per 1000 of deaths were in children under one year of age.

Facts are not wanting to the same effect in this country. *The Preliminary Report on the Eighth Census*, 1860, prepared by Jos. C. G. Kennedy, Esq., the Superintendent, gives some very valuable information on the subject of mortality as influenced by age. From this report we find that, in the year 1860, 393,606 deaths occurred in the United States, and that of this number 81,551 were of children under one year of age, 38,431 between one and two, 23,715 between two and three, 14,657 between three and four, 10,498 between four and five, and 27,492 between five and ten, or a total of 196,344 deaths occurring in children under ten years of age, very nearly one-half the whole number.

As the age of the individual advances, the body becomes more fully developed and is enabled better to resist disease. By the time puberty is attained, which, in the United States, is about the sixteenth year for boys, and the fifteenth for girls, the tissues have acquired considerable solidity, the bones have become harder—though the epiphyses

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* Mortalité des Enfants en Russie. Annales d'Hygiène, 1830, tome iv. p. 330.

† Recherches Historiques et Statistiques sur la Population de Genève. Ann. d'Hygiène, 1837, tome xvii. p. 5.

are not yet consolidated to the shafts, and the circulatory, respiratory, and digestive organs have, in a measure, lost the excessive sensibility by which they were characterized in infancy.

The genital organs, which have heretofore exercised but little influence over the general system, now become capable of performing their functions. In the male the secretion of semen takes place, and in the female menstruation commences. The larynx, which in the infant is small and round, now becomes lengthened, and in the male especially, the voice assumes a more grave tone.

The intellectual faculties have not been behindhand. The brain, though relatively smaller, has undergone consolidation and hardening of its substance, and has, in conjunction with the other portions of the system, lost, to a material extent, the peculiar sensibility to external impressions which belonged to it in early infancy, gaining in strength, in force, and in capacity for improvement.

The relation between the formative and destructive processes is more nearly balanced, and the body has nearly attained the period when growth ceases. This point is in males about the twenty-fifth year, and in females a year or two earlier.

The diseases to which the human subject is especially liable during the period extending from puberty to maturity, are those of the respiratory organs, and others depending upon the presence of the strumous diathesis, which at this time loses the comparative latency which has characterized it and becomes active. From this cause, phthisis, scrofulous enlargement of the lymphatic glands of the neck, and tuberculous inflammation of the joints, are more active at this period than at any other time of life.

Individuals who are about reaching the close of the period of growth are those who, as has been pointed out, are less fitted for the military service, and we have

already considered at length the evils, both to the army and the individual, which result from accepting those who, for want of sufficient development, are unfit for the very arduous life which awaits them in the field.

THE PERIOD OF MATURITY.—Some authors consider that physiologically there are but two periods in the life of man, that of increase and that of decline. Strictly speaking, this view may be the correct one; but there is a time when, if there is any increase in development, it is scarcely perceptible, and if any decline, this is so gradually effected that it is inappreciable by any means at our disposal.

This period may very properly, therefore, be regarded as that at which the formation and decay of tissue are so nearly balanced that the body may be considered as fully mature. Tissue is not, as in the preceding stage, deposited faster than it is removed, but the wants of the system are exactly compensated by the deposit of new material to take the place of that removed as effete.

At the commencement of this period, which ordinarily extends from the twenty-fifth to the thirty-fifth year of life, the epiphyses of the bones become firmly incorporated with the shafts. The flesh becomes hard, firm, and the physical strength is at its maximum. Quetelet,* whose observations have already been referred to, ascertained that the tractile force is greatest at the age of twenty-five, and the manual force at thirty.

The mental faculties, though more strongly developed than in the former period, are not yet at their prime. This is a curious circumstance, and one which is at variance with our preconceived opinions. The influence of the body over the ordinary operations of the mind is well marked. If the physical health is good, the mind, other things being equal, is clearer; but, with reference to

* Treatise on Man, pp. 68, 69.

its maximum power, we find that this is not ordinarily attained till the physical powers have commenced to decline.

The diseases which are most frequently met with during the period of maturity are phthisis and those connected with the organs of digestion.

A most interesting question is that relating to the cessation of the growth of the body. Why, after having attained a certain height and weight, should growth stop? Why do the causes which have been instrumental in developing the several organs and parts cease to exert any longer this developing power, but continue merely to preserve them at a certain fixed point, eventually losing even this power? The views of a distinguished physiologist (Dr. Carpenter) on this point, as expressed in the following observations, are so appropriate, raise so many important inquiries, and are dictated in so scientific a spirit, that they cannot fail to engage the attention of the reader, and excite reflection, if not inquiry, in connection with the serious problem involved.

"Having thus briefly traced the changes that precede maturity, we may ask what is that prevents the processes of growth from advancing at the same rate as they have hitherto done? Why, so long as they are undisturbed by disease or unnatural circumstances, should they not advance *ad infinitum*, or at least why should they not raise man to the strength and dimensions which poets have fabled in their Titans? The same food, the same atmosphere, the same light and heat, the same electric agencies by which the organs have been maintained or excited, are still around them and exerting their influence. Why, then, should they never transcend a certain point? Why should the stature, however much it may vary between a Boruwlaski and an O'Brien, yet never rise above a certain measure? Why does the strength never exceed the powers

of a Milo or a Desaguliers, or the intellect surpass the limits of Aristotle, Shakspeare, or Newton? These are interesting but impossible problems. If we say that a certain quantum of vital power is allowed to the growth of man, and that while a portion is expended in raising him to maturity, the residue must be husbanded for conducting him through the remaining portion of his duration, else he might suddenly stop short in his career without passing those stages that prepare him for the cessation of his existence, what do we gain by such an explanation? Nothing; for the term vital power which we employ, is but a hypothetical cause, or, if more closely examined, is scarcely even this; it is but an abstract term applicable to a number of actions that do not occur in the inorganic world. The vital power of a body is but the collective manifestation of its vital actions, and to say therefore that only a certain quantum of vital power is inherent in it, is but to express in other words the simple fact that these actions are circumscribed. Discarding this explanation, shall we say that the fact must be referred to some deficiency in the media of the being's existence; that although the aliment, the air, the light and caloric are competent to the production of a certain degree of growth, they cannot extend it, and that, were their conditions different, the animal development would be more perfect. It is easy perhaps to suppose this, but we do not see how it can be proved, nor indeed that existing analogies favor it. On the surface of our globe there is every variety in the temperature, in the humidity, and in the electric conditions of the atmosphere, and every diversity in the articles of food employed; in more limited spheres there are the greatest diversities in these several respects, produced artificially by the various occupations of mankind; and, although we find, both among races and individuals, great varieties of development, which may occasionally be traced

to some relation with the media in which they live, these varieties are by no means in proportion to the differences of the media, and in the majority of cases the former are independent of the latter. In the temperate zone, with a due proportion of animal and vegetable diet, man appears to attain his most perfect development, and with however much skill he adapts these circumstances, he never surpasses a certain point, and, from what we know of his physiology, no great alteration in any one of the external stimuli of his existence could be tolerated. A different proportion of the oxygen, nitrogen, and carbon of the atmosphere we know full well to be noxious; a larger or smaller quantity of aqueous vapor suspended in it will occasion many well-known maladies: the same may be said of alterations in the balance of electricity that surrounds us. Great extremes of heat and cold may be borne for awhile, but it is obvious that they are not so well adapted to a healthy state of the system, and therefore to its growth, as intermediate degrees; and consequently it is not easy to conceive any degree either above or below these limits, consistent even with existence. Familiar enough also are we with the effects of full and sparing, of simple and mixed dietetics, and with the fact that between certain well-known bounds lie the salutary quantities and qualities. From all which it appears sufficiently evident, that we cannot conceive any difference in the amount or properties of the known stimuli of life, that would be more favorable to the growth of man, than those which are to be found in the range of the known variations, whether natural or artificial. From the beginning there must have been established a direct relation between the organization of the body and the outward elements; the latter are nothing but stimulants adapted to coexisting susceptibilities, or to put it more closely, man is not made by, but for or with, the surrounding agents; his lungs are fashioned in corre-

spondence with the atmosphere which he breathes, his digestive organs with the food which is spread so plenteously before him, and his nervous system to the subtle imponderable agents that play around him; consequently as his organs only act in concert with, and do not result from, the media of his existence, a development beyond that which he is known to acquire must proceed quite as much from the former as from the latter; and the supposition, the value of which we have been endeavoring to estimate, thus falls to the ground. If man could become a larger, more powerful, or more sagacious animal than he now is, he must not only live in different media, but must possess a different constitution; in other words, the characters that distinguish him as a species must be altered. The question, then, that offered itself remains to our apprehension unsolved by either of the hypotheses. The limitation of man's development is like the definite period of his duration, and a hundred other circumstances connected with his existence, an ultimate fact; no event that we are able to discover intervenes between its production and the will of the Deity."*

So far as the foregoing remarks are applicable to the body of man, they seem to be eminently just. The limitation of his development in this direction is an ultimate fact which we can no more deny or explain than we can the existence of a principle which we call gravitation. We know that the human body is no taller or heavier now than it was thousands of years ago, that the heart beats just as often, that the liver secretes just as much bile, that the muscular strength is no greater. We accept it then as a law of our being that development is to go so far and no farther. That is all we know about the subject. But so far as the observations quoted refer to the mind of man, I

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* Cyclopedia of Anatomy and Physiology, vol. i. article *Age*.

deny their application. With an eminent physiologist of this country I too may say that my faith in the intellectual capacity of man is supreme. We know that since his creation his mind has undergone, and is still undergoing, progressive development, so that it is more advanced to-day than at any former period in the history of the world, and will be more expanded to-morrow than it is to-day. Judging then by what has passed, I dare not fix a limit to the development of the human intellect. On the contrary, I believe, most religiously, that though there are many things which we do not now comprehend, or only dimly perceive, the time will come when everything which the Creator has done for us, or the world in which we live, will be made perfectly clear to our understanding. This does not necessarily require an increase in the size or weight of the brain above that now possessed by that organ, for the mind has no definitive or constant relation to the matter of which it appears to be the resultant.

THE PERIOD OF DECLINE.—The period of decline is marked by as striking characteristics as those which belong to the period of increase. After the body has remained at nearly a fixed point of development for a few years, varying from five to ten, a disposition is manifested to degeneration. The process of decay becomes more powerful than that concerned in the regeneration of tissues, and in consequence the body not only loses weight from the atrophy of its parts, but the functions are less perfectly performed. Thus the action of the heart becomes weaker and less frequent; the respiration slower; the digestion weaker; the muscles thinner; the skin shrunken; the joints stiff; the teeth fall out; the hair becomes gray; the arteries become ossified; and the entire form loses its elasticity and becomes less erect than in adult age. The whole tendency of the body is to consolidation. The generative function is altogether lost in both sexes, and in the female the menses cease to flow.

The organs of special sense also become affected. The eye loses its brightness, and the sight grows dim and presbyopic; the taste is less acute, and the sense of smell is almost, if not altogether, lost at a comparatively early period.

With these changes the mind also participates. The memory is the first faculty to fail, and the others follow in rapid succession.

If these alterations are gradual and uniform throughout the system, death from old age is the result; but it rarely happens that derangement of some one important function does not produce this result before the general breaking up of the vital principle occurs.

During the first ten or fifteen years, the decay of the organism is so slowly effected that very little inconvenience results, and occasionally we meet with individuals who are able to withstand the tendency to degeneration to a very advanced period of existence; but it is nevertheless progressing, imperceptibly it may be, but surely, to the extinction of that mysterious principle we call life.

Such is a brief outline of some of the conditions which attend the period of decline. The diseases to which it is especially liable are those which are related to the principal organs of life: apoplexy, paralysis, organic diseases of the heart and lungs, of the large vessels, of the liver and urinary apparatus, are frequently encountered. The predisposition to malignant diseases is greater during this period than at any other, especially in the female sex, in which also a critical period occurs from the cessation of the menstrual function, during which the procreative organs are extremely liable to disease. Chronic rheumatism is also very common.

Individuals who have reached the period of decline are not well suited for the military service. The fatigues incident to the profession of the soldier are such as they can

ill bear. During the first portion of it, say from thirty-five to forty years of age, these remarks can scarcely be regarded as applicable, because, as has been observed, the regression of the organism takes place at a very slow rate, and produces no very striking effects; but at a later time of life they cannot be too strongly insisted upon, for when the system has lost its elasticity and the power of recuperation which distinguished it in youth and adult age, it has parted with two of the best qualifications which should belong to the soldier.

Moreover, individuals who have entered the period of decline become so subject to catarrhal and rheumatic affections upon the least exposure, that it frequently happens that they spend more of their time in hospital than in the ranks of their regiments. An examination of any military hospital will prove the truth of this assertion. It will invariably be found that the greater number of patients affected with bronchial diseases, with lumbago, stiffness and pain of the joints, and with those obscure muscular pains of which we know so little, are individuals who have passed their fortieth year.

Mentally also they are not the best subjects from which to select soldiers. Their habits of life are formed, and it is with difficulty that they are brought under the discipline which is necessary. Moreover when far advanced in years they have lost the hopeful and determined character which is so essential an element in the making of a good soldier.

We have considered the question, Why does the body, after reaching a certain point of development, cease growing? A still more interesting one is, Why does the body, after reaching maturity, begin to degenerate? It is impossible for us to answer this question definitely, and yet we are not entirely without light on the subject. We know that by care, and by attention to hygienic rules, we can very materially prolong life. We know that in consequence

of improvements in the sanitary condition of man the average duration of life has been lengthened several years within the last three or four centuries. Is there not reason to believe that if we studied the laws of our being more closely we could still further prolong our existence? And if we had a perfect knowledge of the laws of health there would be, as we have said, no physiological reason why decay and death should take place except through accidental causes. This view may appear to be a visionary one, but it is nevertheless logical, and we think correct.

First of all, we want an enlightened system of dietetics. We want to be able to determine *a priori* what substances are necessary to repair a certain amount of waste of tissue and no more. This is of itself a most difficult point, but one by no means impossible of attainment. A long series of investigations in regard to tissue metamorphosis is essential before we can even make a beginning in this direction, but from what has already been done we may well be encouraged to hope for more perfect results than have yet been reached. Now all is darkness—we eat without regard to the wants of the system, and sooner or later disorganization ensues. In all inorganic machines we use those substances for the generation of force which are proper, and no more of them than is absolutely necessary; but with the human system no attention is paid to these points.

Next, we want to be able to exercise all the organs of the body to that extent only which will insure their activity, and the deposit of sufficient new material to keep them in a good state of renovation, without leading to excess of either the process of regressive or progressive metamorphosis.

Finally, the proper use of the mind is to be learned. The reaction of the intellectual processes upon the matter of which the body is composed, though sufficiently appar-

ent, is by no means understood, and hence there is a most important influence at work, which acts unceasingly in producing decay of the tissues. In a paper which I published several years since I showed, by experiments instituted upon myself, that increased mental exertion was invariably accompanied by an increased elimination of urea, a fact which sufficiently demonstrates the influence of the mind over the process of tissue decay.* We know, too, how much, nearly all the functions of the body are influenced by mental emotion of one kind or another.

Through the neglect then of laws which we do understand, and from our ignorance of others which certainly exist, death, if not hastened by accident or disease, takes place surely by old age. The process is a gradual one. The functions cease to be performed from inadequacy of the organs, and the vital principle, or whatever else we choose to call it, becomes extinct.

CHAPTER VI.

SEX.

At birth and for some years afterward the differences which exist between the sexes are scarcely noticeable, except so far as different conformation of the genital apparatus is concerned. After puberty other evidences of distinct organization appear, and the several peculiarities which mark the sexes become manifest. In the male the voice becomes rough; the penis and testicles enlarge; spermatozoids appear in the seminal liquor; the chest becomes

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* See also Physiological Memoirs, p. 21.

broader and deeper; and hair makes its appearance on the face, the axillæ, and pubes.

In the female the pelvis enlarges, as do also all the organs of generation; the function of menstruation, which consists in the periodical discharge of an ovum, accompanied with a flow of blood from the uterus, commences; and hair grows upon the axillæ and pubes. In a short time each sex has fully assumed all the characteristics which belong to it, both mental and physical, so that an observer is enabled by a casual inspection to determine at once the sex of the individual. In early childhood these differences are so slight that without an examination of the genital organs it is often impossible to make the discrimination in question.

Besides these differences there are others of a more general character. The male is stronger, more compactly and coarsely built; his features are more marked and prominent; his muscles are more developed; his bones are larger; his whole frame taller and broader. In addition, his nervous system is not so delicately organized.

On the other hand, the female is more delicately and finely organized. Her skin is softer; her features smaller; her muscular system less powerfully developed; her circulation more feeble; and her figure shorter and more slender.

Sex exercises a very considerable influence over mortality. The number of male children born dead is much greater than of female children. In the four years from 1827 to 1830 there were 2597 still-born children in Western Flanders, 1517 of whom were males and 1080 females. In the United States, in 1860, there were 1617 still-born children, of whom 926 were males and 691 females. The mortality is also greater among males immediately after birth. During the two first months after birth, the ratio is 4 males to 3 females; during the third,

fourth, and fifth months 3 to 4; and after the eighth or tenth month a difference scarcely exists.*

The following table, from Quetelet, shows the relative mortality of the sexes for different ages:—

Age.	Male deaths to one female death.	
	City.	*Country.*
Still-born	1·33	1·70
From 0 to 1 month	1·33	1·37
" 1 " 2 "	1·37	1·20
" 2 " 3 "	1·22	1·21
" 3 " 6 "	1·24	1·16
" 6 " 12 "	1·06	1·08
" 1 " 2 years	1·06	0·97
" 2 " 5 "	1·00	0·94
" 5 " 14 "	0·90	0·93
" 14 " 18 "	0·82	0·75
" 18 " 21 "	0·98	0·92
" 21 " 26 "	1·24	1·11
" 26 " 30 "	1·00	0·86
" 30 " 40 "	0·88	0·68
" 40 " 50 "	1·02	0·83
" 50 " 60 "	1·07	1·18
" 60 " 70 "	0·96	1·05
" 70 " 80 "	0·77	1·00
" 80 " 100 "	0·68	0·92

Thus it is seen that from the period of birth to the age of two years the mortality among males is greater than among females. From that time, through the period of puberty, to the age of twenty-one, the mortality is greater among females; but from twenty-one to twenty-six, deaths again predominate among the males. During the child-bearing period the mortality continues greater with females, as it does also in advanced old age.

The number of males born exceeds the females. From more than fourteen and a half millions of observations made in France, from 1817 to 1831, it was ascertained that the males were in the proportion of 106·38 to 100. The proportion in other countries of Europe is shown in the following table:—

* Quetelet, op. cit. p. 29 et seq.

States and provinces.	Males to 100 females.
Russia	108·91
Milan	107·61
Mecklenberg	107·07
Belgium and Holland	106·44
Brandenberg and Pomerania	106·27
Kingdom of Two Sicilies	106·18
Austrian Monarchy	106·10
Silesia and Saxony	106·05
Prussian States	105·94
Westphalia and Grand Duchy of the Rhine	105·86
Kingdom of Wurtemberg	105·69
Eastern Prussia and Duchy of Posen	105·66
Kingdom of Bohemia	105·38
Great Britain	104·75
Sweden	104·62
Average for Europe	106·

In the United States the number of males very sensibly exceeds the females. In a recent work* on the subject of population and other statistics of the United States it is stated that—

"The excess of male population in the United States, compared with that of the other sex, presents a marked difference with respect to other countries. While in the United States and Territories there is an excess of about 730,000 males in more than 31,000,000 of people, the females of the United Kingdom of Great Britain and Ireland outnumber the males some 879,000 in a population of little more than 29,000,000. This disparity is the result of many causes. The emigration from the mother country of men in the prime of life, and the large demands of their military, naval, and marine services seem to account for some proportion of the excess of females; while immigration from all parts of Europe, our small military and naval

* Preliminary Report on the Eighth Census, 1860, by Jos. C. G. Kennedy, Superintendent.

service, and the few losses we have sustained from the contingencies incident to a state of war, have served to exhibit a larger male population in proportion than can be shown in any country on the globe.

"The great excess of males in newly-settled territories illustrates the influence of emigration in affecting a disparity of the sexes. The males of California outnumber the females near 67,000, or about one-fifth of the population. In Illinois the excess of males amounts to about 92,000, or one-twelfth of the entire population. In Massachusetts the females outnumber the males some 37,600; Michigan shows near 40,000 excess of males; Texas 36,000; Wisconsin 43,000. In Colorado the males are as twenty to one female. In Utah the numbers are nearly equal; and while in New York there is a small preponderance of females, the males are more numerous in Pennsylvania."

M. Quetelet has made a great many interesting observations relative to the differences between the sexes in height, weight, rate of growth, strength, etc., all of which show the preponderance to be in favor of the male.

The function of generation is that, however, which produces the greatest difference between the male and the female, not only in organization and in the character of the diseases to which they are respectively liable, but also by reflexion on the mental constitution.

The diseases therefore to which each sex is specially liable are mainly those which are directly connected with the generative organs. These in the male consist of affections of the testicles, the prostate, and the penis. In the female they are of a much more varied character, because the genital apparatus is not only more complex but the functions involved are more multiform, relating to the external organs of generation, the uterus, the ovaries, and the mammary glands.

Among the most important derangements of the normal condition to which the female is peculiarly subject, are those which relate to the menstrual function. The period at which this function commences varies acording to climate, being earlier in tropical and warm regions than in those of low temperature. In this country it usually occurs at about the fifteenth year, sometimes a year sooner and occasionally a year or two later. Having commenced, a periodical discharge, consisting of a sanguinolent fluid, takes place every four weeks till about the age of forty-five, when it ceases. It is unnecessary here to enter into the physiology of the subject. It is sufficient to state that the bloody fluid comes from the lining membrane of the uterus, and that an ovum is discharged with it. With the occurrence of pregnancy this periodical discharge is interrupted, and it frequently remains suspended during lactation.

The commencement of menstruation and its cessation constitute critical periods in the life of the female, and exert a great influence upon her health and mortality.

The first discharge is accompanied ordinarily by a variety of abnormal circumstances, such as headache, fever, nervous derangement, pain in the loins and uterus, etc., and even the subsequent returns are often thus attended. If any tendency to tubercular disease of the lungs exists it is exceedingly liable to become developed about the time of the first menstruation. It is mainly owing to this fact that the mortality is so greatly increased among females at the period in question.

The function in those who are healthy in this respect continues about thirty years, when it becomes more or less irregular, and finally ceases altogether. In some women it is very irregularly performed from the first, and this derangement, when it exists, is a fruitful source of the great variety of nervous and debilitated conditions by which so many females of modern society suffer. Perhaps it is not

saying too much to express the opinion, which I am sure is well founded, that there is scarcely a woman belonging to the upper classes of society who is not more or less irregular in her menstrual discharges, and this, too, from causes which are the result entirely of an artificial and abnormal mode of existence. Exposure to cold and damp when thinly clad or shod, late hours in exciting society, the reading of modern works of fiction, thereby exciting the imagination or feelings of a sensitive girl, influence materially the condition of the generative organs, with respect principally to the amount of blood flowing to them, and perhaps above all inhaling the atmosphere of badly ventilated and excessively heated rooms. Irregularity, whether in the quantity of the menstrual discharge or the periodicity of its occurrence, when once inaugurated is very apt to become constant. Congestion of the womb or of its neck is thus produced, and inflammation or ulceration follows.

The period of cessation of the menses is also one which is often marked by the irruption of some latent tendency to disease. Malignant affections of the uterus or mammary gland almost altogether select this period for their appearance, and at this time we find the rate of mortality again increased.

Gall contended that there was a periodical manifestation in men analogous to that existing in females, though of course different from it, and Lévy* holds a similar opinion; the latter states that "young and robust persons do not notice this tendency unless their attention is particularly directed to it; but men feebly constituted, or fatigued by recent hardships, or endowed with a great degree of irritability, or who have reached the period of their decline, perceive the alteration which their health monthly undergoes: their countenance becomes dull;

* Traité d'Hygiène, tome i. p. 122.

their perspiration assumes a stronger odor; their digestion is more laborious, and sometimes the urine deposits a heavy sediment. The feeling of discomfort is general and inexpressible, and the mind participates in it, for it is more difficult to maintain a train of ideas; a tendency to melancholy, perhaps an unusual irascibility, are joined to the indolence of the intellectual faculties. These modifications persist some days and disappear of themselves."

I have certainly noticed in many of my friends this tendency to some monthly periodical abnormal manifestations. This may be in the form of a headache, or a nasal hemorrhage, or a diarrhœa, or an abundant discharge of uric acid, or some other unusual occurrence. I think this is much more common than is ordinarily supposed, and that careful examination or inquiry will generally, if not invariably, establish the existence of a periodicity of the character referred to.

During pregnancy the female is also subject to alterations of the normal course of life. These are in the form of headache, vertigo, neuralgia, palpitation of the heart, heartburn, nausea, vomiting, etc., besides a large number of what might more properly be regarded as disagreeable or uncomfortable conditions rather than positive diseases. Puerperal mania, puerperal convulsions, and puerperal fever, are of a far more serious character, as are likewise many of the accidents which attend labor.

During lactation the system of the female is severely taxed, and as a consequence emaciation often ensues. Besides, the mammary glands become subject to inflammation and abscess.

It is thus seen that from the commencement of menstruation to the termination of this function the female is liable to a peculiar class of diseases and accidents, which materially add to her rate of sickness and mortality.

Digestion is less active in the female than in the male,

the consequence of deficient muscular power in the stomach and intestines. Women, therefore, rarely indulge with impunity in articles of food requiring strong digestive power, but should prefer milk, eggs, tender meat, and light alimentary substances. They are more frequently sufferers from dyspepsia than men.

Diseases of the brain are much more common with men than with women. This fact is due to the greater activity of their lives, producing anxiety and excitement. For the same reason diseases of the circulatory system are also more frequently met with among males.

Those diseases which are more or less produced by exposure to inclement weather or hardships, or which are the result of bad habits, are more frequently met with among men than women. Pneumonia, pleurisy, bronchitis, rheumatism, dysentery, diarrhœa, typhoid fever, coup de soleil, delirium tremens, syphilis, and many others, belong to this class.

On the other hand, phthisis, cancer, dropsy, chorea, and several others due to weak or deformed organization, or to irritability of the nervous system, are more common with females than males.

CHAPTER VII.

HEREDITARY TENDENCY.

The hereditary transmission of peculiarities of form, intellectual character, manner, and proclivity to disease, is no longer a subject of doubt by those best qualified to judge in the matter. In fact, to this tendency of like to beget like, we owe the perpetuation of the different species of animals and plants, as well as the great number of

varieties which are produced by the will of man or accidental causes.

We see on every side numerous instances of the existence of the law referred to. The different varieties of the dog, of the ox, and other domestic animals, the various kinds of roses, apples, strawberries, and other plants, are all the results of hereditary transmission.

Resemblances in features to parents are extremely common in the progeny. A child looks like its father, its mother, or perhaps some collateral relative. The hereditary upper lip of the members of the house of Hapsburg is an example of this, and others must be familiar to most persons. In the lower animals the same circumstance is very frequently met with. A whole litter of pups will be marked like the father or mother, or perhaps some like one and the balance like the other.

Certain qualities can also be transmitted. Thus the setter and pointer possess their peculiar qualifications by hereditary descent from ancestors which were taught to indicate the presence of game by the actions they employ.

Deformities are likewise sometimes indubitably transmitted to the progeny. It is by no means rare to find that the immediate ancestors of individuals with superfluous fingers or toes, club-feet, or hare-lip, were also the subjects of these malformations.

In regard to the intellectual cast of the mind there has been more difference of opinion, though we think there cannot be much doubt on the subject. Mr. Buckle, in his classical History of Civilization in England, denies that any tendency exists to the transmission of the qualities of the mind. He says:—

"We often hear of hereditary talents, hereditary vices, and hereditary virtues; but whoever will critically examine the evidence will find that we have no proof of their existence. The way in which they are commonly

proved is in the highest degree illogical, the usual course being for writers to collect instances of some mental peculiarity found in a parent and in his child, and then to infer that the peculiarity was bequeathed. By this mode of reasoning we might demonstrate any proposition, since in all large fields of inquiry there are a sufficient number of empirical coincidences to make a plausible case in favor of whatever view a man chooses to advocate."

This view is very unphilosophical, and one which is opposed to the constant evidence of our senses. If the parents, or either one of them, can transmit to their offspring a peculiar form and quality of brain, the psychical attributes of that brain will also necessarily be transmitted. We are not to forget, however, that education plays a very important part in the matter, and that a child born with a tendency to some virtue, vice, or intellectual trait, may have this tendency entirely overcome, or at least materially modified, by education. Perhaps the most striking instances of hereditary influence are exhibited by those individuals who show a facility or inaptitude for appreciating musical notes. It will almost invariably be found that the ability or inability to acquire a knowledge of music is derived from the ancestry. I have known several instances in which both parents could not turn a tune, or tell one note from another, and in which none of a numerous progeny could do so either.

But the most important part of the subject of hereditary influence which we have to consider is in relation to the transmission of diseases, or predispositions to diseases. Like the transmission of the physical and mental qualities, the transfer of pathological tendencies from parents to offspring must be accepted as a fact amply capable of proof, but not susceptible of explanation. When we say that the seminal fluid, being derived from the blood, must possess the peculiar abnormal impress of the blood, we

assert a proposition just as difficult of demonstration, and in no way an elucidation of the question. Besides, admitting that the seminal fluid of a phthisical person may contain, in an inappreciable form, the germs of tubercles, we could not explain why the offspring of such a person should remain all their lives free from phthisis, and the next generation exhibit unequivocal evidences of tubercular deposits in the lungs. That the tendency to certain diseases is derived from the seminal fluid of the male, and ovaries of the female, scarcely perhaps admits of a reasonable doubt; but that there are other agencies at work capable of influencing the child while yet unborn, is quite as certain. And this fact demands that a distinction shall be made between those diseases, or other peculiarities, which are *connate*, and those which are purely hereditary. By a connate disease we understand one which the child possesses when born, not necessarily the result of any similar taint or impression received from the system of the father or mother, but due to accidents or mental influence operating through the mother. For instance, a child may be born idiotic, not because either of the parents or other ancestors were thus affected, but from the influence of some severe mental shock received by the mother during her pregnancy. Another may be epileptic when neither parent has ever been subject to epilepsy, if either is intoxicated at the time of the intercourse resulting in conception.

Such cases are not due to hereditary transmission, for a disease cannot be communicated hereditarily which has not affected either of the parents or their progenitors.

A singular fact connected with the transmission of diseases (and deformities or resemblances) is, that a whole generation is sometimes passed over, the disease or other peculiarity appearing in the next. We cannot undertake to explain this very remarkable circumstance, but we see

instances of it continually. A father or mother may be phthisical, the children exhibit no evidences of the disease, but the grandchildren die of it; and so of other morbid affections. Or an individual may exhibit some particular trait, either of features or mind, which, passing over his children, appears in the successive generation.

A distinction is also to be made between those diseases which, though hereditary, are congenital, and those which appear after a lapse of time often considerable. Thus, for example, cataract, deafness, and several kinds of deformities belong to the first-named class, but the great majority belong to the second, and arise as a consequence of the predisposition which has been transmitted. They are thus of very great importance to the hygieist, because as the tendency only is transmitted, and this may not be very strong, it is altogether possible frequently to prevent the predisposition being developed into positive disease.

A very striking physiological fact is not without influence upon the laws of hereditary transmission. It is well known that the children of a woman by her second husband may resemble, physically and mentally, her first husband, provided she has had children by the latter. The blood of the fœtus in utero circulates through the system of the mother. This blood has the impress of the father derived through the seminal fluid. It must, therefore, in a greater or less degree, exert an influence upon the organism of the mother. We know this from several facts which will be considered more at length hereafter. Now the husband dying, and the mother marrying again and having children, is the medium of transmitting to this second set of offspring the peculiarities which she has received from her first husband through his children. In this manner the diseases of a man may be transmitted to children which are not his. In the lower animals in-

stances of this species of transmission are far from rare. A bitch will have a litter, one-half of which will resemble, in their markings, their progenitor, and the other half a dog by which she has previously had offspring. In the horse the same fact is also often noticed, and doubtless prevails, to some extent, throughout the entire animal kingdom.

The whole subject of the hereditary transmission of diseases is one of very great interest and importance, and deserves much more careful study than it has yet received. When we understand the laws by which it is governed, we shall have accomplished much toward alleviating a great portion of the suffering to which mankind is liable.*

Phthisis is, of all diseases, that which is most frequently encountered as the result of an inherited predisposition. So generally is this its origin that some authors doubt that it is ever originally produced in an individual. Though this opinion is not correct, the fact that it is held by eminent authorities is of itself a strong proof of the great predominance of phthisis by hereditary transmission.

Occasionally it happens that tubercles exist in the infant at birth, but generally this is not the case. Even should they be present at this early period they do not soften until some exciting cause arises, and this event may not take place for several years, and by care and the adoption of proper measures may be altogether prevented.

In the great majority of cases the predisposition to phthisis which may have been inherited, remains dormant in the system till about the age of puberty or later.

I have very little doubt in regard to the capability of

* The Traité Philosophique et Physiologique de l'Hérédité Naturelle, etc., by Dr. F. Lucas, is the best work extant on the subject. Though containing many ideas which at present appear to be absurd, it abounds in much earnest and sincere thought.

altogether arresting the development of the tubercular diathesis. The use of a diet of which animal food forms the larger portion, habitual and systematic exercise, and warm comfortable clothing, together with a residence, during the inclement seasons of the year, in a mild and equable climate, will often prove entirely sufficient to prevent the predisposition from becoming active.

Gout is another hereditary disease, the liability to which may be much lessened by proper hygienic proceedings, such as attention to the diet, which should be plain but nutritious, systematic bodily exercise, and residence in a salubrious climate.

Apoplexy and organic diseases of the heart, which are also often due to hereditary influence, may be prevented in many instances by the employment of similar measures, and by the avoidance of strong mental emotions and severe intellectual labor. Insanity and epilepsy are also more or less under the control of preventive means.

On the other hand, there are several pathological affections which, frequently the result of hereditary tendency, are not capable of being prevented by any means within our knowledge. To this class belong idiocy, cancer, syphilis, and several others.

When there is reason to believe that an individual possesses a hereditary predisposition to any disease, it is the duty of the medical adviser to study the constitution of his patient thoroughly, in order that he may be better qualified to recommend such measures as are most capable of preventing the manifestation of the threatened disorder. In general terms, these means are such as reason and experience have shown to be most effectual in maintaining the system in a healthy condition under ordinary circumstances. Pure air, light, sufficient clothing, and good nutritious food, conjoined with a due amount of bodily exercise, and, as far as possible, the maintenance of an

equable frame of mind, are the agents mainly to be relied upon. Some diseases require, in addition, special measures of prevention. The limits of this work will not, however, admit of a detailed consideration of these, or indeed of further discussion of the interesting subject of hereditary tendency.

CHAPTER VIII.

HABIT.

WHEN a living being performs an act under the operation of certain impressions which are received, there is a tendency toward the performance of a similar act if like influences are brought to bear upon the organism. Every time the act is performed the disposition to repeat it becomes stronger, until at last the habit is so firmly established that the act is accomplished without the reception of impressions similar to those which originally gave rise to it, but solely through the force of the newly acquired power.

This disposition to repetition is not limited to physical acts; it prevails in regard to almost every function of the body and mind, and forms often an important element in the production of disease.

Habit, therefore, is periodicity, and may be defined as the disposition which the organism acquires, from the frequent performance of certain acts, to repeat these acts until some more powerful force intervenes.

Again, it is well known that the impressions or consequences which result from the action of certain agents

become less marked if the operation of the cause is repeated. Thus the system becomes habituated to the action of alcohol, opium, and many other substances, so that while a small quantity will, in the first instance, produce the characteristic result, the dose must be larger each time that it is taken, or more frequently repeated, in order to be followed by a corresponding effect.

There are many most noxious agents to the action of which the system may become so habituated that no injurious results follow, when, without the protection thus afforded, death would certainly be produced.

The influence of habit over the ordinary operations of the economy is constantly seen; the sensations of hunger and thirst are experienced at stated periods of the day, because by frequently eating or drinking at those times the system, as it were, expects a repetition, and hence the sensations experienced. The action of the same law is seen in the regularity with which the desire to evacuate the bowels recurs at the same hour of the day when by habit we have become accustomed to the act at that time; so with the desire for sleep, the hour of awaking, and the inexpressible feelings excited by the want of a cigar or a customary alcoholic stimulant, with many others which must be familar to every reader.

The manners and customs of nations are mainly the result of habit, continued through a long succession of generations. It is as difficult to alter these as it is to change a long-established habit of the individual organism.

Some persons are more under the influence of habit than others; they acquire a habit more quickly and lose it with less facility. . So strong are the unpleasant feelings excited by any interruption in the regular course of their habits that they will endure the greatest inconveniences to indulge them. I know a gentleman whose custom it was to touch a certain tree on the road from his house to the rail-

way station, a distance of about five miles, as he daily went to his place of business. On one occasion, through absence of mind, he neglected this action, and rode several hundred yards before he discovered his omission. Though feeling annoyed, he continued his journey; but the uncomfortable sensation became too strong for him to endure it longer, and, after having ridden nearly two miles past the tree, at the risk of missing the train he galloped back and touched it as usual.

In explanation of the cause of habit we can bring forward nothing very definite. We know that with inorganic matter a force once acquired will continue indefinitely if no more powerful force interferes with it. A ball thrown into the air would continue in motion but for the influence exerted by gravity and friction. We can conceive a similar law to be in operation on organized matter. An impression is made upon the brain, and through the nervous system certain actions ensue. The impression is not effaced with the accomplishment of the resultant act; something of it remains, to be strengthened, perhaps, by a similar impression made the following day at the same time, with similar results. This course may continue from day to day until the impression made upon the brain becomes strong enough to produce the associated actions without aid from without, and thus a habit is established.

For instance, a person is induced to smoke a cigar after dinner. The inducement, whatever it may be, constitutes the impression made on the brain. The persuasion of a friend, the desire to be sociable, or an idea that smoking would prove beneficial to the health, prompts to the act, and the cigar is smoked. It is repeated for the same cause, until at last the act of repetition begins to exercise its effect, and the original incentive is lost sight of in the more powerful one which has taken its place. The habit is now fully formed, and cannot be broken without violence

to the feelings. The oft-repeated impression has left its traces each time until at last it assumes a local habitation and becomes permanently fixed in the brain, not to be lost unless through some more powerful influence acting in a similar manner to the first.

A habit may be acquired for a disease, and thus a very powerful cause of predisposition brought into action. An attack of pneumonia, for example, leaves the individual more inclined to another seizure than before, and so with many other diseases.

The most striking instance of a disease being kept up by habit is furnished by intermittent fever. There can be no doubt that after the disease has been fairly established through the influence of malaria, it is continued often for several months after removal to a healthy climate by the force of the habit which has been acquired by the regular occurrence of the oft-repeated paroxysm. Indeed, so strong is the influence of habit in producing the phenomena which, collectively, are known as intermittent fever, that it is quite possible to produce the disease artificially as it were.

The very interesting experiment performed by M. Brachet affords us conclusive evidence on this point. This observer took a bath in the Seine every night at twelve o'clock toward the end of October, 1822. This was continued for seven successive nights. After each bath he went to bed, covered himself warmly, in a short time became very hot, and finally broke out in a copious perspiration. Discontinuing his cold bathing at the expiration of the seven days, M. Brachet was very much surprised to find that, at the hour for taking his bath, he was attacked with shivering, fever, and perspiration in regular order, and not to be distinguished from an ordinary attack of ague. For six successive nights he was thus affected. On the seventh, about midnight, he was summoned to attend a case of

labor; the ride heated him, and the heat was continued by his standing for some time in front of the fire, and thus the habit was broken up.*

The influence of long-continued bleeding hemorrhoids is also such as to show the force of habit in a very striking manner. A certain quantity of blood is lost every day, and the system thus becomes accustomed to the abnormal condition. If this state is altered by the removal of the hemorrhoids giving rise to the loss of blood, hemorrhage is apt to occur from some other part of the body, or serious disease is excited.

In the next place, certain bad habits are to be considered. Many of these exercise a very deleterious influence over the economy, even if slightly indulged in, while others are bad more in name than in reality, and only positively obnoxious when carried to excess. Some are acquired by the act of the individual, and are more or less under his control, while others result from causes not subject to his action. The principal morbid habits to which man is liable will be considered under their appropriate heads in the following chapter.

* Watson's Practice of Physic. Am. ed., p. 482.

CHAPTER IX.

MORBID HABITS.

NERVOUS SYSTEM. *Encephalon.*—There are several conditions of the system, the result of habitual thought in certain fixed directions, which can be more appropriately considered as morbid habits of the encephalon than under any other head.

Nostalgia is one of these, and is of peculiar importance in its relations to the military service. The derivation of the word—νόστος, a return home, and αλγος, pain—sufficiently indicates its meaning.

Although there is ordinarily in an active campaign sufficient diversion for the mind, of such a character that it is impossible for the soldier to fix his thoughts for any great length of time on home and its associations, when winter comes, and it is impracticable to continue operations, or when garrisoning posts where but little variety marks the days as they drag slowly along, the mind of the soldier who has a home instinctively turns to the fireside he has left. Imagination pictures to him the events which are there transpiring; at night he dreams of them, awaking in the morning to pass another weary day in pining for the companionship of those he loves, and for the scenes amid which he was born. The continuation of such emotions eventually produces a diseased condition of the mind, and, by sympathy, disorder in the functional operations of the organism. The most prominent symptom is a general emaciation from want of appetite and defect in the powers of digestion and assimilation. This is conjoined with an excessively depressed state of mind, during which nothing diverts the thoughts from home and its remembrances.

The music of some familiar song aggravates the deplorable condition. So strong is the influence of music that it has often been found necessary to prohibit the regimental bands from playing airs which could recall or freshen the memories of home. At length, if relief be not afforded, fever appears, and the patient gradually sinks and dies of sheer exhaustion.

The viscera, which are secondarily affected, are mainly those of the abdominal cavity. Thus the appetite disappears from want of tone in the stomach, and the concentration of the thoughts on a more engrossing subject; there may be vomiting, diarrhœa, palpitation of the heart, and sometimes convulsions and delirium.

M. Laugier* reports a case of nostalgia in which, after death, the cerebellum was found disorganized, and M. Devaux† details a similar case, in which, among other evidences of organic disease of the brain, a hydatid was found in the right lateral ventricle. The first-named writer appears to think the lesion the consequence of the nostalgia, while M. Devaux holds the reverse view. The latter is most probably correct, as we know that disease of the brain will give rise to abnormal ideas, and there is no reason why an abnormal desire to be at home might not also be thus excited. Pinel‡ regards nostalgia as a form of melancholia, in which opinion he is undoubtedly correct.

Some nations afford more examples of nostalgia than others. As a general rule the more mountainous and wild the country the more prone are the natives to nostalgia when removed from it. The Swiss, the Savoyards, and the Laplanders are peculiarly the subjects of this affection. The American Indian also readily dies of grief if separated from the scenes amid which he has lived. On the con-

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* Recueil de Mémoires de Médecine, de Chirurgie, et de Pharmacie Militaires, tome viii. p. 179.

† Recueil de Mémoires, etc., tome xi p. 248.

‡ Nosographie Philosophique, etc., 5eme édition. Paris, 1813, tome iii. p. 97.

trary, the negro is little liable to mental disorder, even when forcibly abducted from his home and sold into slavery. So far as my observation extends, individuals of the Anglo-Saxon race exhibit little proclivity to nostalgia. The cause of this immunity is doubtless to be found in the fact that this race is, above all others, especially the American branch, the least attached to localities.

Young persons are more subject to nostalgia than individuals of mature age. In the army this is particularly the case, almost all the examples of it occurring in soldiers who have not reached their twenty-first year.

The best means of preventing nostalgia is to provide occupation both for the mind and the body. Idleness is the great immediate cause, obviously, for the reason that time and opportunity are afforded for the indulgence of the imagination. Thus it is that the affection is apt to occur among the inmates of the hospitals, especially in those who are wounded and confined to their beds, though capable of fully exercising their minds. Soldiers placed in hospitals near their homes are always more prone to nostalgia than those who are inmates of hospitals situated in the midst of or in the vicinity of the army to which they belong. In the one case the reminiscences of home are more powerfully brought before the mind, while in the other the current of thought is more liable to run in another direction. Besides, being near one's home is always a stimulus to the hope of reaching it, which expectation not being realized the nostalgic condition is developed; while, when it is certain that under no circumstances can a return to one's fireside take place, the mind accepts the terms so imperatively imposed, and ceases to hope for what is impossible of attainment.

Baudens,* in alluding to this subject in a letter to the Minister of War, says:—

* La Guerre de Crimée, p. 36.

* * * "Hospitals for six thousand men, in addition to the regimental hospitals, would be sufficient for the sick of the army. The transportation of patients to Constantinople, of so frequent occurrence at present, so injurious to them, especially in bad weather, and so expensive to the government, would be far less frequent. The hospitals at Constantinople, which require to be purified by disuse, would thus be kept in reserve for secondary use; a portion of the attendants and furniture being sent to the Crimea. It would be wise to build, near the monastery of St. George or at Constantinople, a large depot for convalescents, for it is of the utmost importance that these emigrant fleets should be stopped. The best means of increasing the *morale* of the troops and of putting an end to the desire to return home—natural enough, but destructive of discipline—is to altogether do away with this sending off of the sick; which, to my mind, has led to great abuses, since, of one hundred patients sent to Marseilles, but ten were fit subjects for the hospital."

Similar language might at one time have been justly used in regard to our own armies, and even now is applicable to some extent. There can be no doubt in regard to the injurious results of sending men to the vicinity of their homes. Not only is the desire to be with their friends greatly increased, and the tendency to nostalgia augmented, but the military spirit is weakened. Hospitals should, so far as is possible, be as near the lines of the army as is compatible with the security of the establishments from the attacks of the enemy.

Hypochondria is another affection properly to be alluded to under the present head. This condition is brought about by the continued action of the mind upon some one organ or function which is supposed to be disordered. It is possible, by this concentration of thought, really to produce derangement, and even positive disease of the organ

upon which the thoughts are fixed. This is especially the case as regards the heart. Hypochondria is more frequent in males than in females, and is almost altogether a disease of civilization. Men of letters, statesmen, *savans*, and, in general terms, educated persons, are more subject to it than the laboring classes. Many most whimsical cases of it are to be met with scattered through the literature of medicine.

It very often is the case that hypochondria is primarily due to some derangement of the chylopoietic viscera. When such is the case the efforts of the physician should be directed to its correction. When there exists a tendency to this affection, the mind should be kept occupied with matters which will divert the thoughts of the individual from himself, and, at the same time, sufficient physical exercise should be strictly enjoined. Traveling affords an excellent means of accomplishing these ends. I doubt if any case of hypochondria could withstand a trip on horseback to the Rocky Mountains or a pedestrian tour through Switzerland.

The Special Senses.—The organs connected with the special senses are also liable to contract morbid habits, which interfere with the complete performance of the functions belonging to them. The sense of sight is thus deranged by *myopia*, *presbyopia*, and *strabismus*, all of which may be produced by habit, or continue through the influence of this power, long after the cause has ceased. Persons have been rendered myopic by reading in a bad light, rendering it necessary to hold the book close to the eyes. I know of a case in which the affection was produced by this cause in a single evening. Individuals who are much in the habit of working at employments requiring them to look at very small objects, are generally more or less myopic.

On the contrary, persons who are obliged to view distant objects intently, become presbyopic.

Strabismus is often continued through the force of habit, and is sometimes produced by it. Children who are rendered strabismic by the reflex action of an irritation, excited in the intestinal canal by worms, are rarely cured without an operation; the habit established becomes permanent. Strabismus is also produced and rendered permanent by the intentional squinting which some persons indulge in, either in imitation of others or through a bad habit which they have acquired.

It occasionally happens that the sense of smell becomes altered through the influence of habit, but the instances are not frequent. The same may be said of the other special senses.

CIRCULATION.—Palpitation of the heart is often kept up by habit after having been excited by another cause, such as mental emotion, the excessive use of alcoholic liquors or tobacco, full living, venereal excesses, etc. Persons of nervous temperament are more subject to palpitations than others; thus they are frequent in weak hysterical females, especially if there is any disorder of the menstrual function. Students, especially medical students, are also very subject to palpitations simulating organic disease of the heart. Two causes are generally in operation: excessive mental labor, whereby the digestive and assimilative functions are deranged and irregularity excited in the action of the heart by sympathy, and the concentration of the thoughts upon the disorder thus produced. Physical exercise, the avoidance of late hours, a reduction of the amount of intellectual exertion, and successful efforts to divert the thoughts from the heart, will generally suffice to effect a cure. It has been remarked that in studying the diseases of the heart medical students are very apt to imagine their own hearts to be disordered. It is perfectly possible to produce organic disease of the heart through the influence of the mind. The fact has been verified frequently in times of great national excitement.

Epistaxis.—Few persons reach the adult age without having been subject to nasal hemorrhage in their youth. It may become habitual, and the attacks of it can scarcely be arrested without danger to the organism. As the individual advances in age the habit is gradually lost.

Hemorrhoids.—The discharge from hemorrhoidal tumors is also one of those morbid habitual evacuations which cannot be suddenly arrested without a liability to disease of some other part of the body. Hemorrhage from the lungs, apoplexy, and inflammations of important viscera may be induced by the immediate removal of hemorrhoidal tumors, which, by the discharge from them, have served the organism almost in the capacity of a natural emunctory. Great care should therefore be exercised in attempting their cure, and efforts should always be made to provide some channel, easily under control, through which the system can act in getting rid of matters which it has been accustomed to discharge.

An attack of simple hemorrhoids always predisposes to another. A portion of the blood, which has been collected to form the tumor in the external pile, always remains in the sack, and the tone of the vein being, in a measure, lost, a recurrence is always to be expected. In the internal form of the disease the vessels, both arteries and veins, are concerned. The structure of the tumors thus formed is such that they bleed freely on the slightest touch, or from any cause which temporarily interferes with the free circulation of the blood in the hemorrhoidal vessels.

Respiration.—The respiratory organs are the subjects of certain morbid habits. *Bronchitis* frequently becomes habitual, and may exist for years without disturbance to the general health of the individual. Some children show a predisposition to be attacked with *spasmodic croup*. I have known several in which, at the approach of night, throughout the whole winter, huskiness of the voice and

the peculiar croupy cough invariably appeared. As they advanced in years the habit became less marked, and finally disappeared entirely. *Asthma* is also often kept up by habit.

DIGESTION. — *Flatulence* is frequently habitual, and present for a long period without being due to any disease of the alimentary canal; at other times there is simply a slight loss of tone in the coats of the intestines.

Besides the air swallowed with the ingesta, the intestinal gas is derived from the decomposition of the food and secretions, and is also directly exhaled by the intestinal mucous membrane. A very considerable portion of the gas is absorbed again into the system, where it enters into other combinations; the remainder is expelled from the body by the mouth or anus. Oxygen, nitrogen, carbonic acid, hydrogen, carburetted hydrogen, and sulphuretted hydrogen are the gases which enter into the composition of the intestinal flatus.

The secretion of gas in the intestines is controlled by several circumstances. The practice of bolting the food, sedentary habits, dyspepsia, and intense mental occupation or anxiety, all give rise to an increase in the quantity of intestinal gas. By the avoidance of these causes, the amount formed can be very much reduced. Medicines exercise but little influence in diminishing the quantity of flatus; certain stimulant and aromatic substances, by increasing the peristaltic action of the intestines, cause it to be more readily given off.

Vomiting.—It appears to be essential to the health of some persons that the stomach should be regularly evacuated by vomiting. Lévy* quotes from Raymond a curious case of this kind. "An illustrious and holy prelate having been accustomed to vomit every morning be-

* Op. cit., tome i. p. 195.

fore breakfast a watery mucus without taste or color, followed by the expulsion of a little yellow and bitter bile, enjoyed excellent health, but removing to Paris was persuaded to abandon the habit. He therefore ceased to provoke vomiting by means of a feather, with which he tickled the fauces. He had only given up his habit four days when he was attacked with a fever, preceded by chills; this was accompanied by weight and pain in the head, and was soon followed by a violent delirium. His valet, who was fortunately acquainted with his peculiarity, seeing him in this state, did nothing more than to push the feather down his throat, which act was immediately followed by the expulsion of the fluid which he was in the habit of vomiting. By this means the fever, the delirium, and the pain in the head were immediately caused to disappear. Since then this very worthy and truthful prelate produces vomiting every morning by means of his feather. It can be justly said that by this means he has maintained a perfect state of health and a long life, for he has reached his eighty-seventh year."

I have myself known several persons who vomited every morning immediately on rising from bed, and who enjoyed excellent health. Infants vomit habitually without experiencing any of the disagreeable sensations which ordinarily accompany the act in adults. Repletion of the stomach seems to be the only cause necessary to excite it in them.

Some few persons have the power of vomiting at will by a forcible contraction of the abdominal muscles. The eminent physiologist, M. Brown-Séquard, possesses this faculty.

Females, from a vicarious excretion of the menstrual discharge, vomit, at the usual period, a dark, grumous, bloody fluid. This is unaccompanied with derangement of the health. On the contrary, if this elimination is prevented

in any way, the symptoms attendant on suppression of the menstrual flow are produced.

Diarrhœa.—Frequent discharges from the bowels may be perfectly compatible with health in other respects. I have known several persons who had habitually five or six fecal evacuations daily, and yet who presented no evidences of ill health. Every experienced practitioner must have met with similar cases. Sometimes the stools are thin and serous, at others of the natural consistency. Strong peristaltic action of the bowels, and constriction of the abdominal muscles, come on at stated periods which have become fixed by habit.

It is dangerous to attempt the cure of a diarrhœa which, through the force of habit, has become firmly established. A case was not long since under my care in which the patient had attempted to arrest a diarrhœa which he had had for several years, by taking large doses of acetate of lead and opium. He succeeded in stopping it, but was the next day attacked with headache and fever. Inflammation of the meninges of the brain supervened, and he died in a few days.

The diarrhœa which attacks infants during the teething process cannot be arrested with safety. Cerebral inflammation or congestion is generally the consequence of success in this direction.

Constipation is another condition of the intestines which is habitual with some persons. Instances are on record in which individuals have been several months without an evacuation from the bowels, and with no derangement of the general health. The case reported by Monte-Santo,* of Padua, to the French Academy of Sciences, and which was verified by MM. Græfe and Frank from personal examination, is very remarkable, and might, very reasonably,

* Medico-Chirurgical Review, July, 1833, (American edition,) p. 236.

be doubted, but for the high characters of the observers. In this case there had not been a discharge, *per anum*, for fourteen years. There was always vomiting in from two to five hours after each meal, and about once a month a large quantity of fecal matter was discharged in the same manner. Some time previously a case had been reported to the Academy in which there had been no discharge of feces or urine (by the ordinary channels at least) for a period of seventy-two years.

Habitual constipation is extremely difficult of removal by any merely medical treatment. Regular physical exercise, with, above all, persistent efforts to have an evacuation every day at a fixed hour, will be found far more efficacious. By going regularly to the water-closet at the same hour daily it will often happen that the difficulty will be overcome. The influence of habit over these discharges from the bowels is doubtless familiar to every one. When regularity is established, the desire to go to stool returns at the same hour. If the tendency is resisted, it is not long before constipation becomes the rule.

SECRETIONS AND EXCRETIONS. *The Skin.*—The perspiration may be abnormally large in quantity, or may be altered in regard to its composition, without derangement of the general health. We find some persons whose hands and feet are always bathed in perspiration, or the excretion may be profuse in other parts of the body. Weak and phlegmatic individuals are those in whom excessive perspiration is most generally encountered.

Fetid perspiration is also occasionally met with. It is one of those affections which, though not disqualifying a man for service in the army, should, out of regard to those who may be his associates, lead to his rejection.

Many skin diseases are habitual, and cannot be cured, if extensive, without danger to the general health. Great care should therefore be exercised in treating them.

The Kidneys.—The amount of urine excreted is very much controlled by habit, but there are so many other factors entering into the matter that it is impossible to determine with accuracy the extent to which habit alone is capable of acting. The times of urination are obviously regulated by habit. The desire to evacuate the contents of the bladder returns without fail at the period of the day when we are accustomed to empty this viscus.

The secretions of the *mammary glands*, of the *salivary glands*, and other organs are also controlled, to a great extent, by habit, but present no features of peculiar interest for our consideration in this connection.

THE GENERATIVE ORGANS.—The morbid habits connected with the generative organs are very important in their physiological, hygienic, and moral relations. Some are beyond the immediate control of the individual, while others are more or less due to vicious propensities, which he is able, if so disposed, to successfully combat. Many books have been published in regard to them, but few writers have risen to a sufficiently scientific and comprehensive view of the subjects in question. There are many difficulties in the way of treating of the abuses of the generative organs, for what may be honestly intended as a warning may have a directly opposite effect by exciting the prurient imagination of the reader. Persons who have not made themselves the victims of these vicious habits do not require such books, while those who have indulged their passions to an injurious extent are apt to disregard the warnings, and gloat over the examples of licentiousness and debasement which are unfolded to the imagination.

The abuse of the organs of generation is calculated to lead to very serious results, though I think the extent to which it is carried and the consequences which ensue from it have been grossly exaggerated, for their own purposes, by the designing mountebanks who flood the world with

their miserable books, and shock every feeling of modesty by the shameless advertisements they crowd into the public newspapers. But no doubt can exist relative to the very injurious effects produced upon the organism by the too frequent emission of the seminal fluid in males, or the oft-repeated recurrence of the sexual orgasm in females.

In *masturbation* the mischief is still greater, because, in addition to the phenomena which accompany the sexual act, the imagination is more or less brought into action to produce the necessary mental impression. In this manner the stimulus to the emission of semen, or to the corresponding actions in the female, instead of being derived from the natural source, has its origin in the mind. By frequent repetition, the intellectual powers become weakened, and, in extreme cases, epilepsy and imbecility are produced.

The act of masturbation in the male is far more injurious than in the female, because it is accompanied in the former case by a seminal loss, which does not attend in the latter. The body therefore sooner becomes debilitated through the exercise of this pernicious habit in the male than in the female.

For the elaboration of the semen the highest degree of organic power is necessary. The testicles of very young persons, whose systems are yet undeveloped, are not capable of secreting this fluid; and toward old age, when the organism is declining in strength, the power becomes deficient, and is eventually altogether lost. The body therefore becomes severely taxed if the emissions of the seminal fluid are too frequent; sufficient time is not afforded in the intervals for the system to recuperate, and the semen which is secreted is imperfectly formed, and does not possess the same vivifying power as that which has been secreted through the ordinary and natural action of the testicles.

The manifestations of deficient vital power in the organ-

ism are well marked. The digestion is generally the first function which is affected. Dyspepsia becomes established, and diarrhœa is not infrequently a troublesome and debilitating accompaniment. The circulating system participates. The action of the heart is feeble, rapid, and irregular; palpitations are almost constantly present, and upon auscultation a bellows murmur is found to accompany the ventricular contraction. The countenance parts with its natural hue and becomes of a leaden color; the eyes lose their luster, are deep sunk in the orbits, and are surrounded by a bluish circle; the skin becomes dry and harsh; and the hair, no longer nourished as it should be, is deprived of its natural moisture and falls out.

The mental phenomena are not less striking. The masturbator shuns society, becomes morose and low spirited, and evinces an apathy for all kinds of amusements. Eventually, if he perseveres in his vicious practice, the debility becomes extreme, and either phthisis, epilepsy, or some other organic disease is produced.

In the mean time the effect upon the generative system is not to be overlooked. Emission takes place upon the least provocation, sometimes without any manual interference, but solely through mental impressions, derived through the imagination at the sight of some lascivious picture or scene, and this without erection of the penis. After a time, however, this faculty of easy emission is lost. The glans becomes hard and callous, and loses its peculiar irritability to the touch. More violent means of excitation are therefore resorted to, which in turn become inefficacious—and thus the miserable victim of his own pernicious acts progresses step by step in his downward career till the gratification of his passion becomes his only object in life, and paralysis, conjoined with epilepsy and phthisis, unite to terminate his unhappy existence.

The seminal fluid is in such cases, as we have already

stated, imperfectly formed. It becomes thin, loses its peculiar odor, and, on microscopical examination, is seen to be wanting in the spermatozoa which give it its fruitfulness. It appears to lack all the characters of the fluid secreted by the testicles, and is probably nothing but the prostatic liquid conjoined with a little mucus. It occasionally happens that the fluid ejaculated is mixed with blood. Even in cases where the abuse of the generative organs is not carried to such an extent as to induce phthisis and death, impotency is generally the consequence of an inordinate loss of the seminal fluid continued over a few years, especially in those who have not yet reached the adult age.

Such are some of the consequences of masturbation. Medical literature abounds with the most revolting cases of depravity in persons who have delivered themselves over to this practice. Commencing in infancy, through the teaching of nurses, learning at school, or being prompted by the licentious character of much of the literature that reaches the hands of young persons, hundreds yearly find an early grave, grow up weak, puny, and incapable of procreating the species, or terminate their days in an insane asylum. Though this condition of society is painful to contemplate, I am satisfied, from much observation, that it is much less prevalent than is generally supposed, or than the advertising charlatans of the day would have us believe.

With reference to the military life, the subject under consideration is one of great importance, because there is no doubt that the practice referred to is carried on to a very considerable extent in all armies. The life of a soldier is often such that he seeks diversion of any kind that offers itself, and it too frequently happens that in masturbation he finds for a time a relief from the *ennui* of the camp. But if anything has a tendency to de-

moralize the soldier, to unman him, and to render him incapable of attempting aught that requires courage or endurance, it is the practice of this bad habit. Commanding officers have it in their power to prevent it to a great extent by providing employment and recreation for the men under their charge. Idleness is a great incentive to it. When that is guarded against, masturbation is at its minimum.

Much can be done to free an individual from the degrading habit under consideration. Young persons who are suspected should have clearly pointed out to them, by some one in whom they have confidence, the consequences to which they subject themselves by a persistence in this vicious practice. At the same time the mind should be kept occupied with such matters as will tend to lead it away from the contemplation of all lascivious ideas. A well-regulated system of gymnastic exercises is of great importance. Strong bodily exercise indisposes to venereal desires.

Cold bathing is also an excellent anaphrodisiac. A cold plunge-bath taken at night will be very apt to prevent the occurrence of the erotic ideas which (in the earlier stages of the practice at least) precede the act of masturbation. Strong, stimulating food, condiments, and alcoholic beverages should be avoided. In a word, the measures to be employed are eminently hygienic. Many medicines have obtained a reputation as anterotics, but I must confess that I have seen but little benefit derived from their use, with the exception of iron, the therapeutic action of which is due altogether to its tonic properties.

Involuntary Emissions.—Emissions of semen may take place without any venereal desire, or without friction of the glans or other part of the penis. They may occur either during the day or night, and may be the natural result of distention of the vesiculæ seminales or due to a

deficiency of tone and power in the generative part of the organism. If not excessive, they cannot be said to be injurious, especially when they occur at night only. But if they happen often, the results do not materially differ from those which follow immoderate venery or masturbation. Occasionally nocturnal pollutions are accompanied by erotic dreams, but this is not generally the case.

When due to repletion of the vesiculæ seminales, involuntary emission may be regarded as purely natural, and as effecting a healthy purpose of the economy. In youths who have just reached the age of puberty they often occur from this cause, and, if happening not more frequently than once or twice a month, are decidedly salutary in their influence. It sometimes, however, is the case that they are produced night after night, and the subject of them awakes in the morning, instead of refreshed, depressed both in mind and body, and experiencing a degree of lassitude which unfits him, throughout the early part of the day, for much physical or intellectual exertion. Night is dreaded on account of the inevitable occurrence and the disagreeable consequences which follow.

The hygienic measures which have been recommended in masturbation are still more efficacious in involuntary emissions, and the influence of medicines is not altogether to be despised. A pill of camphor and opium taken on going to bed, and continued for a week or two, will often of itself effect a cure. The habit, once broken, is not apt (if proper hygienic means are adopted) to recur.

However we may explain the fact, there can, I think, be no doubt that sleeping on the back is a powerful cause of nocturnal emissions. I have had many cases under my care which were clearly traceable to this cause, and which were cured by the patient avoiding altogether the supine position.

Sea-bathing, a bracing mountain air, and whatever else

is calculated to strengthen the system, can scarcely fail to produce the best results in those cases which are accompanied by debility or an originally weak constitution. As has been already intimated, involuntary emissions occurring infrequently, and in persons of strong physical development, had better be left to be dealt with by nature alone, for so far from being injurious, they are calculated to exercise an effect more beneficial than otherwise.

In the female sex we meet with morbid habitudes which have their seat in the generative organs, but which do not owe their existence to any act of the individual, but are deviations from the healthy standard of functional action. Thus the process of *menstruation* may offer individual peculiarities either in regard to the regularity of its occurrence or the quantity of blood discharged at each period. These are not necessarily attended with any derangement of the health in other respects, and are scarcely subjects for the interference of the physician so long as the general system is not injuriously involved, or distant organs sympathetically affected. Even in such cases more benefit will be derived from hygienic measures than those purely medical.

It must be confessed that American women are very subject to derangement in the menstrual function. This liability is doubtless due to the fact that they pay so little attention to the ordinary rules of health as regards exercise, clothing, the heating and ventilation of their dwellings, etc.

Habitual *leucorrhœa* is common among women. The same causes which give rise to irregularities of the menstrual function induce leucorrhœa. An eminent obstetrician informed me not long since that more than half of his female patients were subject to this disease. The flow may be profuse and yet the general health remain undisturbed; more frequently, however, the system sympa-

thizes and becomes debilitated and relaxed. Efforts should always be made to restore the healthy condition of the parts, and here again exercise, cold bathing, sea or mountain air, attention to diet, to clothing, etc. are the most powerful means at our command.

CHAPTER X.

CONSTITUTION.

By constitution we understand the general condition of the system which is due to the permanent state of the organs of the body. A person may have either a good or a bad constitution, according to the more or less perfect construction and action of the organs by the operation of which life is maintained. In the former case the vitality of the body, the capability for resisting morbific influences, and of recuperation, are greater than in the latter, the functions are performed with energy, the tissues are healthy, and as a consequence derangement and disease are not so liable to occur. On the contrary, persons with weak constitutions are prone to disease upon slight exposure to the operation of causes capable of inducing pathological disturbance. The circulation is weak and languid, and in the extremities, consequently, the temperature is not kept up to the normal standard. Such individuals suffer severely from attacks of disease which a person of strong constitution would pass through without difficulty. It is very much with man as with an artificial machine. If the latter is well made, of good material, the several parts strongly put together and working in harmony with each other, it will resist hard usage better than one which

is made of bad materials, and in which the different parts are not well proportioned, and are constructed without a due regard to the work they have to perform.

Constitution differs from temperament, with which it has sometimes been confounded, in this, that while the latter refers to specific and well-defined differences, due to the particular manner in which certain vital processes react on the mind, the former is more general, and relates to the original structure and integrity of the organs and tissues of the body. An individual may possess any temperament conjoined with either a good, bad, or indifferent constitution. Constitutions differ from each other only in degree of perfection, while the differences between temperaments are peculiar and radical.

A weak constitution is, to a certain extent, capable of being strengthened by proper hygienic measures. A child born in poverty, and reared under circumstances unfavorable to the full development of the organs of the body, such as insufficient food, clothing, light, and fresh air, may, if the conditions are changed at a sufficiently early period, develop into an adult of good constitution. Even at a late period of life much may be done by the employment of sanitary means to strengthen a constitution originally feeble.

The evidences of a feeble constitution are generally sufficiently clear to even a superficial observation. The heart, the lungs, and the nervous system are found to be endowed with less than the normal amount of power, and consequently the functions appertaining to these organs are imperfectly performed. The chest is narrow and flat, the muscles flabby and weak, and the whole system is wanting in tone. As has been already said, persons of weak constitutions do not make good soldiers. They have neither the mental nor physical endurance requisite in those who enter the military service.

A naturally strong constitution may be weakened by excesses, or a neglect of the rules of health. The excessive use of alcohol, inordinate sensual gratification, long-continued exposure to the action of causes capable of depressing the vital powers, and frequent attacks of disease, will break down the strongest constitutions. Many soldiers are thus rendered unfit for service. Originally well constituted and robust, the hardships incident to an active campaign—exposure to all kinds of weather, loss of sleep, want of sufficiently nutritious food and warm clothing, the absence of proper shelter—all tend to impair the normal standard of health. Tissues which in the first place were capable of performing their office in the economy, lose this power in a measurable degree, and the whole organism becomes enfeebled and more susceptible to morbific influences.

It is in early childhood that most can be done to modify original defects of constitution. Weak and sickly children require the utmost care in regard to food, clothing, exercise, etc. A strong meat diet, or at least an abundance of milk, eggs, or other animal food, is absolutely necessary, when it is considered desirable to improve the tone of the system. Much injury is done to children by confining them, as is often done, to a vegetable diet and milk and water. Such children generally remain weak and puny, and become adults of feeble constitutions. The process of hardening, as it is called, is one fraught with danger to the subject upon whom it is tried. Persons of originally sound and robust organization may, by judicious exposure to cold and moisture, become strengthened by the development of their energies; but those who are of feeble constitution are more apt to be overcome than to conquer under such circumstances.

SECTION III.

OF AGENTS EXTERNAL TO THE ORGANISM WHICH ACT UPON THE HEALTH OF MAN.

CHAPTER I.

THE ATMOSPHERE.

THE air is a compound gas of variable density surrounding the globe, and dissolved in the water which constitutes a part of its matter. It is necessary to the life of all organic beings whatsoever. It extends above the earth nearly forty-five miles, and at the level of the sea exerts a pressure of about fifteen pounds to the square inch. The composition of the atmosphere, according to the researches of MM. Dumas and Boussingault, is 20·8 measures of oxygen and 79·2 of nitrogen. It also contains a variable proportion of carbonic acid and aqueous vapor, with traces of iodine, ammonia, and nitric acid. In certain localities other substances enter into its composition, and exert a more or less deleterious influence upon life, and several of the matters which are constantly present in small quantity, when materially increased in proportion, render the atmosphere unfit for respiration.

For the purposes of respiration in animals, the essential constituent of the atmosphere is the oxygen, the nitrogen merely serving as a diluent, and not being absorbed into the system through the lungs. It is by volume, as we have seen, about one-fifth the total bulk; but within certain

limits this proportion is probably subject to variation, according to the situation of the locality where the air is collected. Thus, along the sea-shore, M. Morren found the amount of oxygen in 100 volumes of air to reach 23·67 parts. Dalton, and subsequently M. Babinet, found that the proportion of oxygen sensibly diminishes as the altitude increases, so that, according to the last-named observer, at the height of 10,000 metres above the level of the sea, the quantity of oxygen in 100 volumes of atmospheric air is but 18·12.

Boussingault, who examined the air collected from the Andes, and Brunner, who analyzed that of the Faulhorn, came to the conclusion that the composition of the atmosphere does not vary for altitude. The experiments of Dumas* are to the same effect; but Lewy† found the air collected at sea, and but a few feet above its surface, to contain less oxygen than the air of the land.

The atmosphere is not, therefore, a fixed chemical compound, but simply a mechanical mixture of oxygen and nitrogen in perhaps variable proportions, to which are added certain other gaseous matters, also in no certain quantities.

The physiological and chemical properties of oxygen are such as render it the most important constituent of the atmosphere. It is the element which, above all others, is most powerful in maintaining life, and, at the same time, is that which exerts the greatest influence in effecting the destruction of all organic forms. It also enters into combination with all elementary substances, with the single exception of fluorine. Pure oxygen, when in-

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* Annales de Chimie et de Physique, 1841, tome lxxviii. p. 257.

† Kæmtz Cours Complet de Météorologie, p. 66; see also Annales de Chimie et de Physique, 1843, tome viii. p. 425, for M. Lewy's observations in full.

haled, is not capable of supporting life for any considerable period. It acts so energetically that life is destroyed just as we see a piece of charcoal, which burns gradually and without commotion in atmospheric air, consume rapidly and with a burst of scintillations, when ignited in pure oxygen.

Inhaled in a diluted form, as it exists in the atmosphere, oxygen unites with the carbon of the blood and is expired as carbonic acid. A portion of it enters into other combinations, which are excreted by the kidneys and skin, being the products of the destructive metamorphosis of the animal tissues.

The property which the atmosphere possesses of supporting combustion is due entirely to its oxygen. But this fact affords no certain indication that air in which combustion is maintained is fit for respiration. Life soon becomes extinct in an atmosphere in which a candle will continue to burn, as can be shown experimentally.

Nitrogen is in many respects the very opposite of oxygen, its properties being almost entirely negative. It does not support combustion, and though it is found as a constituent of all the animal tissues except fat, it is not capable of answering the purposes of respiration. An animal confined in an atmosphere of nitrogen dies as quickly as it would in a vacuum.

As has been said, there are other matters found in the air which, though not essential to its composition, are too important in their influence upon health to be disregarded. Some of these are gaseous, as carbonic acid, ozone, etc., and others are morphological, as spores of fungi, infusoria, etc. These we propose to consider in the following chapter.

CHAPTER II.

THE ACCIDENTAL OR NON-ESSENTIAL CONSTITUENTS OF THE ATMOSPHERE.

THE matters embraced under this head are those which are not regarded as essential to the composition of the atmosphere, though generally present in it as a whole, or in the air of certain localities.

CARBONIC ACID.—This substance is present ordinarily in the proportion of from four to six parts in ten thousand of air; but, under certain circumstances, this ratio is very considerably augmented. It is greater at night than in the day by almost one-third, owing, perhaps, to the fact that, through the influence of the sunlight, it is absorbed from the atmosphere by plants. The proportion of carbonic acid present in the atmosphere is greater according as the altitude increases, the air collected from around the summits of high mountains containing more than the air of the plains. It is also present in larger quantity in the atmosphere of cities than in that of the country—MM. Boussingault and Lewy finding at Andilly, in 10,000 parts of air, 2·909 of carbonic acid, and at Paris 3·190. Dr. Ramon de Luna* found that the air within the walls of the city of Madrid contained in the mean 0·517 parts of carbonic acid in 1000 of air, while without the walls the mean quantity was but 0·45.

Ramon de Luna also examined the air of bed-rooms before and after ventilation. The air collected from one of

* Etudes Chimiques sur l'Air Atmospherique de Madrid. Annales d'Hygiène, tome xv. 2d série, p. 337.

them at six o'clock in the morning was found to contain 4·8 parts of carbonic acid in 1000, with a very appreciable amount of organic matter, while, after two hours' complete ventilation, the proportion of carbonic acid was reduced to 1·6, and the organic matter, though still present, was in less quantity. Thus, even after the "complete ventilation," the proportion of carbonic acid present in the room was more than five times what it ought to have been.

Leblanc* found the amount of carbonic acid in one of the wards of the Salpêtrière to be as high as 6 parts, by weight, in each 1000 parts of air; equivalent to 4 parts by volume, which is ten times the ordinary proportion. In another ward it very considerably exceeded this quantity, being 8 parts in 1000.

In a room containing 1280 cubic feet of air, in which I slept, and in which all the openings were carefully closed, I found in the morning at seven o'clock 0·95 parts of carbonic acid to the 1000 of contained air—somewhat over twice the ordinary quantity. After free ventilation by a strong current of air passing through it for three hours, the amount of carbonic acid was reduced to 0·43, or about the normal quantity. When we come to consider the subject of ventilation, we will treat of this matter more at length.

Carbonic acid, when pure, is irrespirable; the glottis closing spasmodically, prevents its entrance into the lungs. Even air containing as much as 40 per cent. cannot be respired. Leblanc† having placed a dog, a Guinea-pig, a bird, and a frog in a close vessel of 22·5 metres cubic capacity, supplied it with a large quantity of carbonic acid. After seven minutes the dog appeared to be uneasy, and after three-quarters of an hour he was suffering severely; the bird and the Guinea-pig likewise suffered a good deal,

* Annales de Chimie et de Physique, tome v. 1842, p. 223.

† Annales d'Hygiène, tome xxx. 1er série, 1843, p. 54.

and the frog was very much inflated. The air collected at this time contained 30·4 per cent. of carbonic acid. Notwithstanding this large amount of impurity, the animals all recovered when exposed to fresh air.

The experiments of Regnault and Reiset* show that an atmosphere containing as much as 23 per cent. of carbonic acid will support life, provided at least 40 per cent. of oxygen be also present. Bernard,† on the other hand, found that a bird died in two hours and a half in an atmosphere containing 39 parts of oxygen, 48 of nitrogen, and 13 of carbonic acid. Bernard's experiment is, however, open to the objection that the air was confined and loaded with the organic exhalations from other animals which he had previously placed in the bell-glass.

I confined a sparrow under a large bell-glass, having two openings. Through one of these I introduced every hour 1000 cubic inches of an atmosphere containing 45 parts of oxygen, 30 of nitrogen, and 25 of carbonic acid, allowing the vitiated air in which the animal had respired partially to escape. At the end of twelve hours the bird was in as good a condition as at the commencement of the experiment, and when the bell-glass was raised, it flew away as if nothing had happened to it. A mouse subjected to a similar experiment also suffered no inconvenience.

Experiments of this character would lead us to the conclusion that carbonic acid is not positively poisonous, but only negatively so, when its presence is unaccompanied by a due amount of oxygen. When this latter gas is present in the proportion of two parts to one of carbonic acid, life can be sustained. Direct experiment also leads to the same conclusion. I have repeatedly injected carbonic acid

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* Recherches Chimiques de la Respiration des Animaux des diverses Classes. Paris, 1849.

† Leçons sur les Effets de Substances Toxiques, etc., p. 132.

gas into the cellular tissue of rabbits and dogs without the least injurious result, and have even introduced it with impunity directly into the blood.

The cases which are on record of the frightful results which have followed the crowding together of many persons in circumscribed areas, are ascribable to two causes— the deprivation of oxygen, and to the emanations from the bodies of the sufferers. The instance of the one hundred and forty-six Englishmen confined in the Black Hole at Calcutta, a room eighteen feet square, and with but two small windows, illustrates these points. Mr. Holwell,* who was one of those imprisoned, has given a very graphic account of the torments he and his companions endured. He specifically refers to the urinous odor which pervaded the prison, and the symptoms, as described by him, are such as would be produced by intense animal poisoning. He says: "Here my poor friend, Mr. Edward Eyre, came staggering over the dead to me, and, with his usual coolness and good nature, asked me how I did, but fell and expired before I had time to make a reply." No asphyxiated person could have acted in this manner. Of the one hundred and forty-six imprisoned at eight o'clock in the evening, all but twenty-three were dead by six o'clock next morning.

Many other instances might be adduced, showing the fatal effects of over-crowding; all of them indicating that the organic matters exhaled from the bodies of the victims were more at fault than the carbonic acid. This whole subject will engage our attention more fully hereafter.

Owing to the greater density of carbonic acid gas, it occupies the lowest stratum of the atmosphere in places where it is confined. Thus, in vats it is always found at the bottom. In the Grotto del Cane, near Naples, it extends

* Annual Register, 1758, p. 282.

but for a few inches above the ground. A man can walk through the place with perfect safety, but a small dog falls asphyxiated at once. For this reason, patients in hospitals should be placed on bedsteads in preference to being made to lie on the floor.

The opinion is not intended to be expressed that an amount of carbonic acid in the atmosphere over the normal quantity is not injurious. It is hurtful, inasmuch as to the extent that it is present it prevents the absorption of a corresponding amount of oxygen.

IODINE.—The existence of iodine in the atmosphere, first affirmed by Chatin,* has been assented to by some investigators and denied by others. Chatin's observations were confirmed by a commission of the French Academy of Sciences, and subsequently by Mr. T. J. Herapath,† of Bristol, in England. Herapath caused the air to impinge upon a glass slide on which a mixture containing starch was placed. After a period varying according to the direction of the wind, the state of the atmosphere as to moisture, etc., the glass always, when submitted to microscopical examination, showed the presence of iodine in the blue color of the starch granules. I have several times repeated Herapath's experiments, and always with affirmative results. There would appear, therefore, to be no doubt on the subject. No very exact results have been obtained relative to the absolute amount of iodine in the atmosphere, but comparative observations show that it is more abundant in the vicinity of bodies of water than in other localities. The air of the sea-side contains it in comparatively large proportion. On the contrary, the air about the summits of high mountains, and also that of the valleys, is deficient in it, as is likewise the water of these situations.

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* Comptes Rendus de l'Académie des Sciences, tome xii. p. 1006.

† Chemist, vol. iv., 1857, p 193.

The principal source of the iodine of the atmosphere is water, both that of the sea and of the rivers and springs. A great portion of the benefit derived by invalids from a residence at the sea-shore is to be ascribed to an increased amount of iodine taken into the system through the lungs. The expired air contains but a fifth part of the iodine of the inspired air, the balance being fixed in the blood.

SULPHURETTED HYDROGEN.—This gas is only found in the atmosphere collected from localities where decomposition of organic matter or certain inorganic substances is progressing. Thus it is exhaled from sewers, cesspools, and privies, and is also disengaged from marshes, rivers, and mines and volcanoes. Sulphuretted hydrogen is exceedingly poisonous. Dupuytren* found that $\frac{1}{800}$ of this gas was sufficient to render the atmosphere so poisonous that small birds were killed in a few seconds when subjected to its influence. One part to two hundred and ninety-nine parts of atmospheric air proved fatal to a dog. Chaussier† found that one part in two hundred and fifty of air sufficed to kill a horse. On the other hand, a commission‡ appointed by the Parisian authorities to examine into the best means of cleaning the sewers of Paris, and composed of MM. D'Arcet as president, Gaultier de Claubry, Parent-Duchatelet, and others, found that their workmen could breathe, without inconvenience, an atmosphere containing one per cent. of sulphuretted hydrogen, and that they constantly breathed air in which from twenty-four to ninety thousandths were present. On one occasion Gaultier de Claubry remained sufficiently long in a sewer to collect the air, which, upon analysis, was found to contain 2·99 per cent. of sulphuretted hydrogen.

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* Dictionnaire des Sciences Medicales, tome ii. p. 391.

† Journal de Médecine de Sedillot, tome xv. p. 28.

‡ Annales d'Hygiène, 1829, tome ii. p. 1 et seq.

Drs. Christison and Turner* found that four cubic inches and a half of sulphuretted hydrogen, diluted with eighty volumes of air, caused the death of a mignonette plant.

Hallé describes at length the effects of this gas on man as it was exhaled from certain privies of Paris. When inhaled in a concentrated form, sudden weakness and complete asphyxia are produced. The individual becomes weak and insensible, and falls down dead without convulsive action. If the quantity of sulphuretted hydrogen be moderate, the symptoms are more varied; vertigo, coma, convulsions, and vomiting are caused. Death ensues if the individual be not quickly removed into the fresh air.

The results of my own experiments with sulphuretted hydrogen do not differ materially from those of other observers. I found, with Dupuytren, that all small animals, as birds and mice, were killed by a smaller proportion of the gas in the atmosphere in which they were confined than larger animals. Sparrows and mice did very well in an atmosphere $\frac{1}{1000}$ of which was sulphuretted hydrogen. With more than this, death ensued, though not till twenty or thirty minutes had elapsed. These animals, if placed under a bell-glass containing pure sulphuretted hydrogen, died immediately, without any convulsive action. On *post-mortem* examination, the blood was found perfectly dissolved, and the blood corpuscles completely broken down.

The action of sulphuretted hydrogen, when inhaled in large quantity, appears to be that of a narcotic poison. Its effects upon the organism, when its action is long continued in small amount, have not been so thoroughly investigated as is desirable. That it is capable of producing injurious results, is very certain. Dr. Christison† states

* A Treatise on Poisons, etc., by Robert Christison, M.D. Am. ed., p. 618.

† Ibid., p. 620.

that at one time, when he took no precautions against inhaling the gas, he remarked that daily exposure to it in small quantities caused an extraordinary lassitude, languor of the pulse, and defective appetite. Dr. Taylor* refers to the instances which occurred of poisoning by this gas in the workmen engaged in excavating the Thames Tunnel. By respiring the atmosphere of this place the strongest men were in a few months rendered extremely weak, and several died. The symptoms were giddiness, nausea, and extreme debility; fever, accompanied by delirium, supervened. In one case which Dr. Taylor saw, "the face of the man was pale; the lips were of a violet hue; the eyes sunk, with dark areolæ around them; and the whole muscular system flabby and emaciated."

Dr. Daniell and others have supposed that the active agent of malaria in causing fevers is sulphuretted hydrogen. Although there is no doubt of the exhalation of this gas from marshes, rivers, and other places, giving rise to malaria and the consequent production of fevers, there is no proof that it is the principle to which these diseases owe their origin. On the contrary, the symptoms produced by sulphuretted hydrogen have very little analogy with those caused by malaria.

The disease which occurred a few years since at the National Hotel in Washington was undoubtedly due to emanations from a sewer, the active agent of which was probably sulphuretted hydrogen. A stream of gas from a sewer, sufficiently strong to extinguish a lighted candle, was found flowing into the cellar of the house. The symptoms produced were very similar to those observed by Dr. Taylor in the workmen of the Thames Tunnel. After death, ulcerations of the small intestines and inflammation of the mucous membrane of the colon were observed.

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* Medical Jurisprudence. Am. ed., p. 609.

Sulphuretted hydrogen is readily detected by its action on the salts of lead. A slip of paper, moistened with a solution of the acetate of lead, for instance, becomes brown or almost black, from the formation of sulphuret of lead, when subjected to the influence of an atmosphere containing this gas.

CARBURETTED HYDROGEN. — The carburetted hydrogen gases, which are those used for illuminating purposes, are also found in the atmosphere as evolutions from decomposing organic remains, or as escaping from mines, volcanoes, etc. Though deleterious, they are not so poisonous as sulphuretted hydrogen, and may be inhaled in a tolerably concentrated form without much inconvenience. Sir Humphrey Davy inhaled a mixture of two parts of air and three of carburetted hydrogen. He immediately became giddy and faint. He then inhaled it in a pure state. The first inspiration produced numbness in the muscles of the chest; the second caused great oppression of the lungs; at the third inspiration he nearly lost consciousness, becoming at the same time very weak and faint. In less than a minute he again became sensible, but the feeling of impending suffocation and weakness continued for some time. It is probable that the mixture contained carbonic oxide, to which the effects produced were mainly due. The carburetted hydrogen was formed by the decomposition of water by red-hot charcoal.

Several instances are on record of death being produced by the inhalation of impure carburetted hydrogen. Devergie* gives the history of a case in which one person died, and four others nearly perished, in consequence of sleeping in a room in which the gas-pipe leaked.

Carburetted hydrogen gases are disengaged in consider-

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* Asphyxia par le Gaz de l'Éclairage, etc. Ann. d'Hygiène, tome iii: p. 457.

able abundance from coal mines, and are inhaled, unless in a concentrated form, with impunity by the miners. The very decided odor which belongs to them serves as a warning of their presence.

It would appear that the deaths caused by illuminating gas have been due to carbonic oxide, present as an impurity, more than to the carburetted hydrogen of either kind. I caused a rabbit to inhale a mixture of pure light carburetted hydrogen (prepared by heating four parts of dried acetate of soda, four of fused potassa, and six of quicklime) and atmospheric air, in the proportion of one part of the former to two of the latter, without any notable symptoms being produced. Even when in equal proportion with the air, the animal did not appear to suffer. Olefiant gas was likewise found to cause but little inconvenience when employed in the same proportions. Two parts of either mixed with one of atmospheric air caused death in about half an hour, more from the deprivation of oxygen apparently, than from any positively poisonous influence exerted by the gases in question. I have also injected them directly into the blood with impunity. Illuminating gas obtained from the distillation of coal always contains an appreciable quantity of carbonic oxide, to which its directly toxic power is due.

The difference in the results obtained by causing animals to inhale the ordinary illuminating gas is well marked. I have frequently subjected birds and rabbits to its action, and even when present in as small a proportion as the fortieth of one per cent., death was caused in a few minutes. When pure, the animals were killed at once.

Light carburetted hydrogen is given off in large quantities from marshes, and it has been assumed that it is the morbific agent which is present in malaria. There is no reason, however, to support this view.

NITRIC ACID AND AMMONIA.—These substances are normally present in the atmosphere. According to Fresenius, one million parts of atmospheric air contain during the day ·098 parts of ammonia, and during the night ·169 parts. The nitric acid is found in larger quantity during and immediately after thunder-storms. It is not known that they exert any particular effect upon the health of man, as their quantity is extremely small.

OZONE.—Various opinions have been expressed by chemists relative to the nature of this substance, which was discovered, in 1839, by Schönbein, as a constituent of the atmosphere. According to the views of this investigator there are two allotropic conditions of oxygen: one, that which is constantly present in the atmosphere in fixed proportion; the other, which is occasionally present, and which may be formed from ordinary oxygen by various agents, the principal of which are electricity and phosphorus, is designated as ozone, a term—from ὄζω, to stink—which sufficiently expresses one of its characteristics. Schönbein originally regarded ozone as a gaseous peroxide of hydrogen; but his later investigations have led him to the conclusion that it is oxygen in an active state—in fact, an allotropic form of that element. In this view he coincides with the opinion held by Berzelius, De la Rive, and others, and which has since been sustained by Dr. Andrews* in a very complete series of experiments.

Ozone is formed whenever electricity is passed through a column of atmospheric air. The peculiar odor which is evolved from the working of an electrical machine is due to the formation of ozone. It may also be produced by decomposing aqueous solutions of certain acids and salts by gal-

* Quarterly Journal of the Chemical Society of London, 1857, vol. ix. p. 169.

vanism, the ozone appearing with the oxygen at the positive pole. When phosphorus is slowly oxidized in atmospheric air, ozone is formed. Marignac produced it readily by drawing air through a long glass tube containing a few pieces of pure phosphorus. The ozonized air was then passed through water to absorb the phosphoric acid, and collected in a bell-glass. Phosphorus placed under a bell-glass, in presence of a little water, causes the formation of ozone. It is also probably produced when two flints are rubbed together, though Prof. Hare* failed to recognize it.

Ozone formed by either of these methods possesses the power of setting iodine free from its combination in iodide of potassium, and upon this fact depends the value of the test which is commonly used to indicate its presence. A mixture made of one part of iodide of potassium, ten parts of starch, and one hundred parts of water constitutes the reagent. A piece of white filtering paper moistened with this compound, and exposed to the influence of ozone, becomes brown or bluish, from the action of the iodine set free upon the starch, whereby an iodide of starch is formed. This reagent is not, however, a positive indication of the presence of ozone, for nitric acid and several other substances likewise possess the property of setting iodine free from its combination with potassium, and according to Cloëz certain vapors and oils given off from vegetable matters exercise a similar power. Nitric acid, being an almost constant constituent of the atmosphere, may give rise to a serious source of fallacy in the use of the test in question.

Ozone is a very powerful oxidizing agent. The moisture which is deposited as dew contains it in considerable proportion, and it is on this account that iron so readily rusts when exposed to dew.

* Silliman's Journal, 1851, vol. xii. p. 434.

In its effects upon the health of man it is highly probable that ozone exerts a very powerful influence, although as yet we are unable to adduce any positive evidence on the subject. Schönbein, as far as his investigations extended, was of the opinion that it is highly provocative of bronchial affections, and especially of influenza. During an epidemic of this disease he found an augmented quantity of ozone in the atmosphere.

From his experiments, Schönbein also concluded that ozone is absolutely destructive of malaria. So far as this point can be determined from the effect of ozone in neutralizing the odor of putrefying animal and vegetable substances, there can be no doubt of the correctness of this opinion. I have been able to confirm it entirely by subjecting putrescent meat and vegetables to the action of ozone in very small quantity, and invariably the bad smell was at once corrected. But such experiments afford no conclusive proof that ozone can counteract the effects of malaria, for as yet we are not positively certain in regard to the nature of this agent, still less can we say that it is the matter which causes the peculiar odors of putrescent substances. According, then, to the views of this investigator, when there is an abundance of ozone in the atmosphere malarious diseases prevail but to a limited extent, if at all. In winter ozone is present in a greater amount in the atmosphere than during the summer months, and this fact is brought forward by Schönbein in confirmation of his conclusions, for, as is well known, miasmatic affections are more prevalent during the latter than the former season. He also found that the higher strata of the atmosphere contained more ozone then those nearer the general surface of the earth, and as malarious diseases are less prevalent in high altitudes than in the low lands, he finds in these facts further confirmation of his views. Although the facts stated are strong presumptive evidence in favor of his

theory, they are far from being conclusive. Clemens,* by a series of very interesting experiments, appears to have established the fact of an antagonism existing between ozone and malarious emanations; and several other observers have, by independent observations, arrived at similar conclusions.

With reference to the influence of ozone over the production of cholera, there is also a difference of opinion. Whether any direct relation exists between the quantity of ozone in the atmosphere and the prevalence of cholera or not, there appears to be no doubt that the presence of this disease is generally accompanied by a minimum amount of ozone in the air of the locality where it prevails. Berigny,† who made a large number of important observations relative to ozonometry at Saint Cloud, found that there were more cases of cholera among the soldiers who inhabited the first story of the barrack there than in the upper stories, and that the atmosphere of this first floor contained less ozone than that of the other floors.

Leaving the investigations of others, I come to my own experiments in relation to ozone and its connection with the occurrence of diseases.

With Schönbein I found that ozone is exceedingly destructive to animal life, and that birds or mice, when placed in an atmosphere containing not more than $\frac{1}{10000}$ of ozone, died in a few minutes, with all the symptoms of asphyxia. The mere smelling of it was sufficient to excite in me a violent irritation of the Schneiderian and bronchial mucous membranes, which lasted for several hours. This action was one which Schönbein had previously no-

* Comptes Rendus, July 7th, 1856.

† Rapport sur les Observations Ozonometriques, etc. Recueil des Mémoires de Méd., de Chir., et de Pharm. Mil. 1856, tome xviii. p. 480 et seq.

ticed, and which led him to the supposition of the superabundance of ozone during catarrhal epidemics.

At Fort Riley, in Kansas, where I was stationed several years since, I observed that the workmen who lived in the low alluvial region of country bordering the river were extremely subject to intermittent fever, while those, with the soldiers, who inhabited the barracks built on the high ground about half a mile from the river, were not at all affected. I found, by using Schönbein's ozonometer, that ozone was, during the warm season, present but in very small quantity in the atmosphere of the former locality, while in the latter it existed in much larger proportion. My observations were numerous on this point, and led to uniform results.

During my service at that post cholera prevailed on two occasions to a very great extent. While it continued, the air was dry and contained no ozone. At least the ozonometric paper failed to exhibit the slightest change in forty-eight hours. The occurrence of a very severe thunderstorm put an end to the epidemic in both instances, and ozone at once reappeared in the atmosphere.

These results differ from those obtained at New York in 1849 by Prof. Ellet* during the prevalence of cholera. This observer found no definite relation existing between the amount of ozone in the atmosphere and the extent to which the cholera prevailed.

It must be very evident to all students of this subject that still further researches are necessary before we can attain to any certain knowledge in regard to it. No doubt can exist that there is a principle in the atmosphere, whether it be ozone or not, which possesses the power of setting iodine free from potassium, and which holds intimate relations with the causes of certain diseases to which

* Transactions of the American Medical Association, 1850, vol. iii.

mankind are liable. Some later writers deny that ozone is ever present in the atmosphere. We are not able to say positively that it is; we only know that there is an element present which possesses the reaction of ozone. Till our ozonometrical processes are improved, it is not probable that we will arrive at any more definite information. There is every assurance that a vast field of inquiry exists in this direction, the investigation of which cannot fail to enlighten us relative to the causation of many diseases which now defy our utmost powers of research.

ORGANIC MATTERS.—The various living animals and vegetables of the earth give off emanations from their bodies, either in a gaseous or morphological state, which are received into the atmosphere, and affect, in greater or less degree, the hygienic condition of man. To the organic matters emanating from the human body, more than to any other cause, the injurious results of overcrowding are to be ascribed. These exhalations escape from the lungs and skin, and are principally in the form of vapor. They are absorbed by the clothing, the bedding, the carpets, the curtains, and many other materials, and even the walls of the rooms inhabited take them up and retain them for a long time.

It is impossible to describe in detail the characters of the organic matters which are exhaled by animals and vegetables. Some of them are perfectly characteristic of the beings from which they are derived. Thus the odors of the musk-deer, of the goat, of certain reptiles, and many other animals, and of an immense number of plants, belong to this class. It is highly probable that every animal and vegetable has its own peculiar smell.

Many vegetable emanations are deleterious to health, and serious consequences, and even death have resulted from them. The volatile principle which escapes from the *Rhus toxicodendron* or poison-vine causes, in some persons,

a violent erysipelatous inflammation of those parts of the skin exposed to its action; and death has been known to ensue from sleeping in a room in which highly odoriferous flowers were placed.

The emanations from the human body are of a decidedly deleterious character when present in large amount in the atmosphere inhaled. Their exact nature has not been satisfactorily ascertained, but enough has been established to show that they consist of various principles derived from the articles taken as food or the products of the destructive metamorphosis going on in the blood and tissues. Any matter of a volatile nature accidentally present in the blood, is also given off both by the skin and lungs. If a small quantity of turpentine, for instance, be injected into the blood of a dog, it is immediately detected in the products of respiration. Persons who have been subjected to the anæsthetic influence of ether or chloroform exhale these substances through the medium of the expired air and the perspiration for several hours afterward.

That the ordinary exhalation from the lungs contains organic matter, can very readily be ascertained by causing the expired air to pass through pure colorless sulphuric acid, as was done by Valentin and Brunner. Through the carbonization of the organic particles the sulphuric acid becomes of a very perceptibly brown color. Permanganate of potassa in solution indicates, with great exactitude, the presence of organic matters in the products of respiration.

That such substances are also present in the sweat, does not admit of a particle of doubt, as they are rendered sensible by the odor. They are frequently oleaginous and acid. I have collected the water given off by the lungs and skin and have always found it to contain organic matter, as indicated by the solution of permanganate of potassa. Moreover, the fact that this water undergoes

putrefaction very readily, is another evidence that it contains organic matter.

When we enter a room in which many persons are contained we are at once struck by the oppressive character of the air. That this is not altogether due to the presence of carbonic acid, is very apparent from the peculiar odor which is evolved. The same is true of a chamber in which any one has slept, and which has not yet been purified by ventilation, or of the bed which has been lain in.

That these organic emanations are hurtful, has already been asserted. The proofs are ample, and are derived from direct experience and experiment. Witness the case already referred to of the Englishmen confined in the Black Hole at Calcutta, and in which the peculiar odor of the air was distinctly noted by the narrator. The symptoms preceding death were altogether unlike those attendant on a mere deprivation of oxygen. Take also the instance of the passengers on board the steamship Londonderry, who were confined, to the number of one hundred and fifty, in a small cabin for several hours, and in which the cases of death, amounting to seventy, were clearly not due to asphyxia. Many others might be brought forward, all of which illustrate the point contended for.

Moreover, disease is produced by the concentrated organic emanations from the bodies of those who have been confined in close and ill-ventilated places. Bacon* alluded to this fact nearly three hundred years ago, when he said that "the most pernicious infection, next the plague, is the smell of the jail when the prisoners have been long, and close, and nastily kept, whereof we have had in our time experience twice or thrice when both the judges that sat upon the jail, and numbers of those who attended upon the business, or were present, sickened and died. There-

* Natural History, Experiment DCCCCXIV.

fore it were good wisdom that in such cases the jail were aired before they were brought forth."

In the year 1577 typhus fever was produced at Oxford to such an extent, by the effluvia arising from prisoners brought into court to be tried, that over five hundred deaths occurred in consequence.

On the 11th of May, 1750, the sessions began at the Old Bailey, in London. About one hundred prisoners were tried, and while the trials were progressing, the prisoners immediately before the court were detained in two rooms opening into the court-room, each fourteen feet long by eleven in width, and seven feet high, equal to 1678 cubic feet, which, if we allow that there were fifty persons confined in each, would give but twenty-one and a half cubic feet per man. The court-room itself was but thirty feet square. It is very easy to conceive the condition of the miserable wretches subjected to this treatment, and the concentrated character of the emanations which they took with them in their clothes to the court-room, and which were given off among the people assembled there, who themselves added to the noxious effluvia. In consequence of this criminal violation of the laws of hygiene many individuals sickened and died, among them four judges, and several counsellors, sheriffs, jurymen, and others present, to the number of forty, without counting those whose condition in life was such that they went unnoticed.*

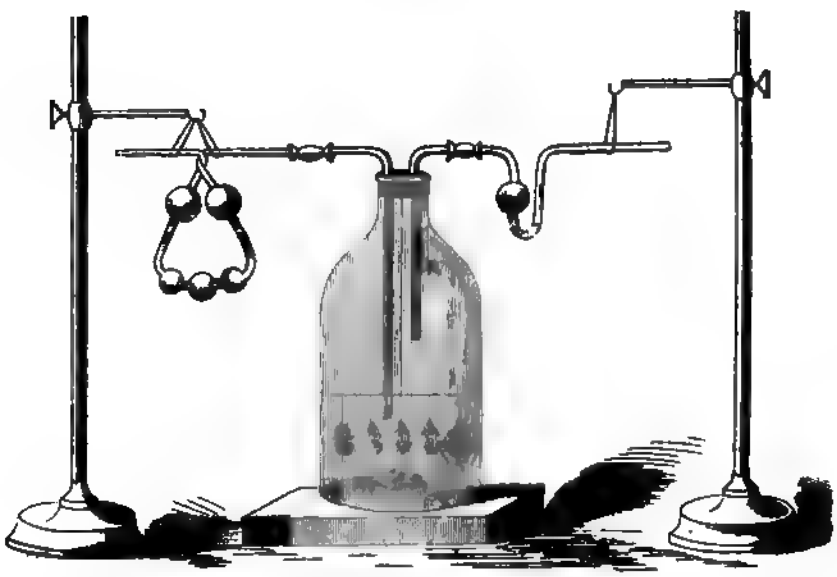
Many other cases might be brought forward similar to the above. So frequent were they in England, before enlightened views began to prevail, that sessions of courts, leading to the development and spread of typhus fever, received the specific designation of "black assizes;" such were the black assize at Exeter in 1586, that at Taunton, and others.

* See Pringle's Observations on Diseases of the Army, edited by Rush, p. 290.

In addition to evidence like that referred to, relative to the poisonous character of the organic emanations from the human body, we have the proof derived from direct experiment. M. Gavarret subjected animals to an atmosphere contaminated with animal exhalations, and though he restored the oxygen as fast as it was removed, and drew off the carbonic acid as rapidly as it was formed, he found that the animals submitted to investigation perished.

My own experiments are to the same point. I confined a mouse in a large jar, in which were suspended several

Fig. 10.



sponges saturated with baryta-water. By this means the carbonic acid was removed as fast as formed, as was proven by the fact that on causing a portion of the air in the bell-glass to pass through baryta-water no carbonate of baryta, beyond a very small quantity, was formed. Fresh air was supplied as fast as it was required by means of a tube communicating with the bell-glass and closed by a little water

in the bend of the tube, which acted as a valve. As the air in the bell-glass was rarefied by respiration and the absorption of the carbonic acid, fresh air flowed in from without, while the arrangement of the tube prevented the air of the bell-glass from passing out. The watery vapor exhaled by the animal was absorbed by two or three small pieces of chloride of calcium. The whole arrangement is shown in Fig. 10.

The mouse subjected to this experiment died in forty-five minutes. The observation was repeated many times, and death invariably ensued in less than an hour. On causing the vitiated air to pass through a solution of permanganate of potassa, the presence of organic matters, in large quantity, was at once demonstrated.

There can be no doubt, therefore, that the organic emanations from the bodies of man and other animals, in a condition of comparative health, are positively noxious, and that too much care cannot be taken to rid our habitations of them. When persons not in sound health are crowded together, we can at once perceive that the exhalations given off from their bodies are possessed of still greater deleterious properties, and hence the increased necessity which exists for purifying the sick chamber and the wards of hospitals. The exhalations in question cling to the clothing, the furniture, the walls, and especially the bedding. These facts are not new; Trotter,* who wrote nearly seventy years ago, in speaking of Dr. Lind's remarks relative to the danger of catching fever from piles of bedclothes and body linen, says: "The washerwomen of Haslar have also told me the same thing. They know when a dangerous fever is in the hospital from the bad smell of the clothes; this makes them air them abroad till the smell is gone, and then they can wash them with

* Medicina Nautica. London, 1797, p. 177.

safety. But if it happened from the hurry that this could not be done, or if it was neglected by design, many of them have been seized with the sickness. The porters and people employed in cleaning and fumigating the blankets and beds at Haslar are well acquainted with this fact, and they measure the danger by the badness of the smell." Many authors of still greater antiquity might also be cited in regard to this point.

In relation to the disposition of the effluvia from patients to be absorbed by the walls of the rooms in which they are placed, the case of the ward in the City Hospital, New York, is a striking instance. Hospital gangrene had occurred in this ward, and though the patients were all removed, together with the furniture, the disease attacked other patients who were placed in it. The ward was then closed for some time, the walls whitewashed, and the whole room thoroughly cleansed and purified; yet when it was again opened for the reception of patients, the disease recurred. The plastering was next scraped off, and new plaster put on the walls; but without avail, the hospital gangrene attacking the inmates as before. It was not until the entire walls were taken down and renewed that the taint was removed.

Three years after the event stated as occurring at the Old Bailey, five carpenters, who were engaged in making the necessary alterations in Newgate, with the view of more effective ventilation, were attacked with typhus fever.*

For the detection of organic matter in the atmosphere, the permanganate of potassa affords a very sensitive reagent. A solution of this substance in water loses its brilliant red color, and the salt undergoes decomposition when

* Adams's Observations on Morbid Poisons, etc. London, 1807, p. 330.

air containing organic matter is passed through it. By the extent to which the loss of color reaches we are enabled to form an approximate idea of the amount of such matter present in the air. The solution is placed in Liebig's bulbs, and the air drawn through it by means of an aspirator. When we come to the consideration of the atmosphere of hospitals, and the means of purifying them, this whole subject will more fully engage our attention.

In addition to the gaseous emanations from plants and animals, the atmosphere contains a vast quantity of organic morphological matters; these consist of pollen, the spores of fungi, starch granules, epithelium cells, pus cells, and perhaps certain peculiar bodies, the existence of which is as yet doubtful.

During the prevalence of the cholera in Great Britain in 1849 several observers announced the discovery, in the air, of what was called the cholera cell. It was asserted that large quantities of these cells were also found in the evacuations of cholera patients. The existence of any such organism is generally denied at the present day. I have frequently sought for it during the prevalence of cholera, but always without success. That diseases may, however, be communicated through the medium of the atmosphere by organic forms suspended in it, is scarcely a subject for doubt. Dr. Parkes* asserts that in the atmosphere of the wards of Fort Pitt, epithelium cells have been detected in several instances, and quotes Eiselt as authority for the discovery of pus cells floating in the atmosphere of a room in which were thirty-three children with purulent ophthalmia.

Pasteur† found that all the animal and vegetable pro-

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* Statistical, Medical, and Sanitary Reports of the British Army for 1860, p. 346.

† Comptes Rendus, February 6th and May 7th, 1860.

ductions which arose in sugared water, mixed with a little albuminous material, were derived from the ova of infusoria, or the spores of mucedinea, floating in the atmosphere. Subsequently he extended his observations to milk and wine with similar results.

Pouchet,* who has given very great attention to this subject, though admitting the presence in the atmosphere of starch granules, textile fibers, etc., denies that the ova of infusoria or the spores of fungi are ever met with. While agreeing with him relative to the great predominance of starch granules, I am sure that I have discovered bodies which presented all the characteristics of ova of infusoria, and spores of cryptogamic plants. The instrument made use of in the examinations did not vary materially from that employed by Pouchet. It consisted of a glass tube, two inches in diameter, closed at each end by a well-fitting cork. One of these corks was perforated so as to receive

Fig. 11.

the pointed extremity of a small copper funnel, the other was connected with an aspirator. The apparatus is shown in the accompanying cut. (Fig. 11.) Into the large tube a

* Comptes Rendus, April, 1860.

square piece of glass was introduced, and placed at the distance of about the one-twelfth of an inch from the extremity of the copper funnel. When the aspirator was set in action by opening the stop-cock, the air entered the funnel and impinged upon the glass plate, where it deposited its morphological constituents. After an hour or two the plate was removed, and submitted to microscopical examination. Frequently I obtained the spores of penicillium and of other mucedines, and occasionally dried infusoria of the more common varieties. The air of hospitals, which I have extensively examined with reference to its containing organic forms, will be more appropriately considered under another head.

Many diseases have been ascribed to a cryptogamic origin, and with very considerable appearance of truth. Prof. J. K. Mitchell held the opinion that malaria owes its essential characteristics in the production of disease to the spores of fungi inhaled into the lungs. I was myself several years since attacked with an intermittent fever after inspecting a large quantity of musty hay belonging to the government. The coincidence may have been accidental, but it is certainly striking when taken in connection with the facts brought forward by Dr. Mitchell.

AQUEOUS VAPOR.—The atmosphere always contains a certain amount of water in the state of vapor, varying in quantity according to the temperature and density of the air, the season, the latitude, the situation, the altitude, etc.

The water in the atmosphere is derived by evaporation from the oceans, lakes, and rivers of the earth. A current of air saturated with vapor at its temperature rises from the earth, and meeting with other currents of lower temperature, loses its vapor, which is condensed into watery particles; these fall to the earth again as rain, hail, or snow, according to the temperature of the strata through which they pass.

The relative amount of vapor in the atmosphere is ascertained by determining the dew-point. This is readily done by placing a little water in a polished metal cup, inserting a delicate thermometer in it, and dropping in small pieces of ice till a slight moisture is deposited upon the outside of the vessel. The point at which the mercury stands in the thermometer gives the temperature of the dew-point, that is, the temperature to which the atmosphere requires to be reduced in order that its vapor should be deposited as water.

Various instruments, called hygrometers, are used for the purpose of ascertaining the dew-point. None of these are very exact. Many simply measure the relative degree of humidity, others require great care in their management, and a troublesome calculation, before the dew-point can be found. The one used in the army is Mason's. It consists of two thermometers, one of which is covered with a piece of muslin or silk, which is kept moist by capillary attraction of water from a reservoir. As evaporation progresses from the wet bulb, the temperature falls, and when it becomes stationary, it is read off and compared with that indicated by the other thermometer. By a mathematical formula, (that of M. Regnault being considered the most reliable,) the dew-point is ascertained. Tables for simplifying the process are found in all works on meteorology, and in the directions issued by the medical department of the army.

The amount of vapor in the atmosphere exercises a very important influence upon certain physiological processes. Thus, the quantity of perspiration and of aqueous vapor given off by the lungs is much less when the atmosphere is loaded with moisture than when it is dry. On the contrary, the quantity of urine excreted is greater in dry than in damp weather, for then the watery particles are given off in greater amount by the emunctories of the skin and

lungs. Edwards* found that air saturated with moisture did not prevent perspiration, though it reduced it to its minimum; and that in dry air the perspiration was from five to ten times greater than in air of extreme humidity. I have repeated his experiments, and with analogous results.

The consideration of the degree of moisture of the atmosphere should be accompanied by that of the temperature. Air that is very moist and warm is debilitating and relaxing in its action, at the same time that it depresses the nervous system. Under the long-continued operation of a humid and warm atmosphere, the phlegmatic temperament is developed to its utmost point, and a tendency to obesity established.

Such an atmosphere is also injurious, from the fact that it is extremely favorable to the decomposition of the organic matter which is contained in the air, and to the consequent production of disease. As Huxham† says: "A moist, warm κατάστασις of the atmosphere relaxes the fibers too much, enervates the power of the vessels, renders the blood of too loose a texture, too glutinous and inert, and makes the whole body dull, unstrung, and languid, and exposed to long, slow, putrid, intermitting fevers. * * * But very often, indeed, while such kind of weather lasts, quotidians and tertians are apt to degenerate into long-continued putrid fevers, and that to the no small danger of the sick; who, if they happen to recover from them, generally fall, in the conclusion, into a jaundice or dropsy. The sick persons, indeed, never recover sooner or more happily than in fair, bright weather, and when the mercury stands high in the barometer. This I have myself constantly observed,

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* On the Influence of Physical Agents on Life. English translation, pp. 35 and 71.

† Observations on the Air and Epidemic Diseases. London, 1767, p. vii. (Preface.)

and the very famous Fred. Hoffman (long conversant in the practice of physic) remarked the same very long since; whereas, when a cloudy, rainy, southerly wind blows, they recover exceeding slowly."

In certain diseases, such as those affecting the pulmonary mucous membrane and the parenchyma of the lungs, a moist atmosphere, unaccompanied by too high a temperature, is beneficial.

A *damp* and *cold* atmosphere gives rise to inflammations, especially of the mucous membrane of the respiratory passage, to rheumatism, and to diarrhœa and dysentery. These effects are probably produced through its influence in lowering the temperature of the body, and in checking the excretion from the skin. A feeling of oppression and uneasiness is thus caused, which is perfectly characteristic. During such a condition of the atmosphere, troops in the field are rendered more liable to scurvy and to typhoid and typhus fevers. Epidemic diseases of all kinds prevail with far more intensity at such times. The mortality from all causes of disease is much greater during the prevalence of the combination of excessive moisture with a low temperature, than at any other period.

Dryness, conjoined with a *high temperature*, is not favorable to health. The loss by the skin and lungs is, under such circumstances, greater than at any other time, and, after a long continuance of a dry and hot atmosphere, it will generally be found that the body has very perceptibly lost weight. The experiments of Edwards, to which reference has already been made, are conclusive on this point, and I have been able to confirm them in all essential particulars.

A *dry* and *cold* atmosphere cannot be regarded as prejudicial to health. Its effects upon the organism are generally of a most exhilarating character. The secretions and excretions are effected with ease, and the balance between

them is well established. This combination is more usually met with in elevated situations.

Under the head of *Temperature*, we shall consider, more at length, the influence of heat and cold upon the human system.

In the next place, we might proceed to consider the various effluvia which are given off by manufactories, and which exercise such deleterious effects upon the vegetation and inhabitants subject to their influence; but this would lead us into the discussion of subjects which, though of great importance, do not come within the scope of this treatise. Some of these noxious vapors will be alluded to more at length under another head.

MALARIA.—The most important subject to be considered under the head of accidental constituents of the atmosphere is malaria. After centuries of observation, however, we appear to have made little if any progress toward ascertaining its composition, though the laws by which it is governed have come to be tolerably well understood, and we are, in consequence, enabled to protect ourselves against its effects.

Two theories relative to its nature especially claim attention. According to one, (which is far the older, having been definitely promulgated by Lancisi in 1695,) malaria is constituted of gaseous emanations from the decomposition of vegetable matter, through the action of heat and moisture. The other ascribes it to the presence of poisonous fungi in the atmosphere, sufficiently minute to be wafted about by the motion of the air, and acting upon the organism through the medium of the function of respiration. This theory was advanced by the late Prof. J. K. Mitchell, and sustained in a course of lectures* which he delivered

* On the Cryptogamous Origin of Malarious and Epidemic Fevers. Philadelphia, 1849.

several years since in the Jefferson Medical College of Philadelphia.

In regard to the first-named hypothesis, the facts that malarious diseases occur where there is no vegetable decomposition, as on the banks of the Tagus opposite Lisbon, the sandy plains of New Mexico, where there is no rain and scarcely any vegetation, and that in many localities where there are vegetable decomposition, heat, and moisture, there are no malarious affections, are difficult if not impossible of being reconciled with the truth of the theory in question. Many other arguments might be adduced against it; so that, while it is true that malaria is generally produced in greatest abundance where heat and moisture are conjoined with vegetable decomposition, no necessary relation between them and this morbific agent has been established.

The theory proposed by Dr. Mitchell appears to me, on many accounts, more plausible; both from what was previously known relative to the poisonous character of certain fungi, and from the facts and arguments he has brought forward in its support. In addition, I have myself noticed several circumstances which appeared to favor it; not the least of which was the occurrence of immense quantities of the spores of fungi in the atmosphere of malarious localities.

If the apparatus figured on page 174 be set in action in a region where malaria is evolved, it will be found that, on submitting the glass plate to microscopical examination, numerous spores of fungi have been deposited. Among them the bassidiospores of hymenomycetous and gasteromycetous fungi will generally be found predominant.

I have already referred to the instance in which I contracted an intermittent fever from (so far as I could determine) inspecting a large lot of damaged hay, and I have frequently suffered from headache, with febrile action, after rummaging among old books which had become musty from long disuse.

Instances of the poisonous action of certain fungi are exceedingly common. In fact, the great majority of them are far from being inert in their action on the animal economy. When the active principle is absorbed into the system, it is difficult of elimination, and, even when excreted, is found still to possess its poisonous properties. These facts are well marked in the *aminita muscaria*, the intoxicating fungus in use by the Tartars of the north-eastern parts of Asia. The active principle, instead of being destroyed, is eliminated by the kidneys unchanged; so that those who make use of it as an intoxicating agent, are enabled to obtain its full effect by drinking their urine passed after a debauch. There appears to be no limit to this propagation through the urine of the poisonous qualities of the aminita, for they may be passed in this way from one person to another, without diminution in activity.

Some years since, Dr. B. W. Richardson* published an article on the narcotic and anæsthetic properties of the *Lycoperdon proteus*, or common puff-ball, as developed in the smoke given off by this fungus in burning. Subsequently, Mr. T. J. Herapath† very decidedly proved that the poisonous principle evolved by the combustion of the lycoperdon was carbonic oxide. Latterly I have caused animals to inhale the spores of the fungus in question, and have invariably found narcotism and anæsthesia produced. In my own person, even when inhaled to a very small extent, a drowsy feeling was always caused. Animals subjected to the influence for any considerable length of time after the induction of coma, invariably died in a comatose condition. On examination after death, the spores were found in the bronchi, stomach, and intestines.

But perhaps the most striking instance of the morbific

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* Medical Times and Gazette, 1858, p. 160.

† Chemist, vol. ii. 1855, p. 761.

influence of the fungi is exhibited by the fact, almost certainly established, that they are the cause of "camp measles." The researches and experiments of Dr. Salisbury,* of Ohio, leave scarcely a doubt on the subject, and constitute a most important addition to our knowledge of the etiology of diseases. Since the commencement of the present rebellion, the troops in camp have suffered to a great extent from measles. I have seen regiments with half their men on the sick report from this cause. The origin of the disease was a mystery. Men leaving their homes in perfect health, would go into camp, and be soon after attacked. Dr. Salisbury, after becoming acquainted with several instances in which a disease not distinguishable from measles had been contracted after the individuals had handled or been in contact with straw in a state of partial decomposition, was led to examine, microscopically, the fungous growths which attach themselves to wheat straw in a mouldy condition. He gives minute descriptions of the spores and cells of these structures.

With a devotion to science, in the highest degree creditable, Dr. Salisbury inoculated himself with the fungi, and succeeded in producing a disease characterized with all the phenomena of measles. His wife, also, with no less heroism, allowed herself to be inoculated, with similar results. Other instances are given, all to the same general effect.

On examination of the straw used by the troops at Camp Sherman for bedding, it was found covered with fungous growths of the same kind as those used for the inoculations. Measles was then very prevalent in this camp.

Dr. Salisbury† mentions other facts bearing on this point, in a paper subsequently published, in which the details of the inoculation of twenty-seven persons with the straw fun-

* American Journal of the Medical Sciences, July, 1862.

† Ibid., October, 1862.

gus, in addition to those previously performed, are given. In all these cases the disease was produced and protection afforded against an epidemic of measles then raging. It would be difficult to present a stronger instance of the relation between cause and effect than that which forms the subject of his memoirs. I am able entirely to confirm his observations relative to the existence of the fungi he describes on moist straw. I have very little doubt that many other diseases will be found to be produced by a like cause. It is highly probable that "hay asthma" is one of these, and I design experimenting on this point as soon as an occasion offers.

The very rapid growth of the fungi is strongly confirmatory of the plausibility of Dr. Mitchell's theory. Thus, Fries counted more than ten millions of sporules in a single specimen of *Reticularia maxima;* and the *Bovista giganteum* has been known to increase in a single night from a mere point to the size of a large gourd. After a rain, it will frequently be found in certain localities that the ground is covered with fungi two or three inches in height, the growth of a single night.

The fact, too, that the fungi grow almost entirely at night, is in strict harmony with the circumstance of the almost exclusive activity of malaria at this time.

Many other strong coincidences might be brought forward; but they are only coincidences, and simply give great probability to the theory under consideration without actually establishing its correctness. This will only be done when it is known that malarious diseases are caused by the inhalation of fungi or their spores, and by no other agency.

No subject connected with hygiene is of greater importance than the full understanding of the laws by which malaria is governed, and these we propose now to consider.

1st. Malaria is more potent in the immediate vicinity of

its place of origin than at even a short distance from its source.

Thus, the individuals living on the bank of a river or border of a marsh, from which malaria is given off, are always more subject to fevers than those situated a short distance from such localities. This fact was very well marked at Fort Meade, in Florida, where I was stationed several years since. The barracks were originally built on the bank of Pease Creek, a small sluggish stream flowing through a thickly-wooded bottom. Intermittent and remittent fevers made such sad havoc among the troops, that new barracks were constructed about half a mile from the first location. The change was productive of the best results; for, though fevers were by no means prevented, they were very much lessened, both in frequency and severity. Numerous instances of the operation of this law must be familiar to every reader.

2d. Malaria is more active in low than in elevated situations.

This was very clearly perceived at Fort Riley, in Kansas, which is situated on a bluff overlooking a low alluvial region, through which the Kansas River runs. One quarter of the barracks is not more than two hundred yards distant from the former bed of the river, which is now covered with a luxuriant growth of cotton-wood, and which is rich in malarious emanations. The laborers, who had their huts in this locality, were exceedingly subject to intermittent and remittent fevers, while the soldiers, who lived on the hill, were rarely affected. Indeed, these diseases were entirely confined to those who either lived altogether in the low lands, or worked in them the greater part of the day.

The instance referred to by Dr. Ferguson is still more to the point. The British garrison at English Harbor, in Antigua, occupied, in 1816, three sets of barracks. One of them was situated on Monk's Hill, six hundred feet above

the marshes, which evolved a most intense malaria. The others were situated on a height called the Ridge, one five hundred feet, and the other three hundred feet above the marshes. Those officers, soldiers, women, and children who lived in the barracks on Monk's Hill had no fever of any kind; those who inhabited the barracks on the Ridge at five hundred feet, were scarcely affected; those who were quartered in the barracks at three hundred feet, had remittent fever; while those who had to stand night guard at the marshes, were frequently attacked with violent delirium at their posts, and died within thirty-six hours, with yellow skin and black vomit.

Rigaud de`l'Isle,* in speaking of the malaria of Italy, says:—

"Let us suppose an observer placed upon the coast; he considers the inhabitants; he sees them in summer, and more particularly in autumn, with a livid tint, shining skin, the abdomen distended, a lounging, listless gait, mostly afflicted with putrid and malignant fevers. He directs his course to one of those elevated rocks which I have described; he ascends, and as he rises, he finds no other fever than the simple intermittent; by degrees this also disappears; he meets with no faces but what exhibit a ruddy glow, and all the appearances of health and vigor.

"Which way soever he turns, the same phenomena present themselves; in every quarter diseases pursue the inhabitants of the plain, and spare those of lofty mountains; hence he cannot help inferring that the bad air does not rise so high as the latter, and that it must therefore possess a greater specific gravity than the ordinary atmospheric air."

The Pontine Marshes are noted for the highly concen-

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* Influence of Tropical Climates on European Constitutions, etc., by James Johnson, M.D., etc., vol. ii. Philadelphia, 1821, p. 111.

trated malaria which arises from them. Sezza is nine hundred and eighteen feet above their level, and the inhabitants are altogether free from malarious diseases.

It is to be understood that what has been said applies to height relatively, not absolutely. There are many instances of malaria being given off from localities situated at very considerable heights above the level of the sea. Thus, the Pueblo village of Laguna, in New Mexico, has an altitude of over 5000 feet, and yet it is very subject to intermittent fever, produced by the malaria evolved from a marsh in the immediate vicinity, at a very little less elevation. Humboldt* and other travelers mention several examples of a similar kind.

Even the difference in elevation between the first and second floors of a dwelling is important, those living in the higher stories being much less liable to malarious diseases.

3d. Malaria is very much more noxious during the night than the day. The greatest degree of activity appears to be manifested at about the time of the rising and setting of the sun.

I have witnessed many examples of the correctness of these propositions. Their truth is familiar to all observers, and especially to the inhabitants of malarious localities. Thus, to pass through the Pontine Marshes after sunset is almost certain death; while in the daytime little danger is encountered. Many instances have occurred of travelers contracting fevers, resulting in death, from a neglect of proper precautions in this respect.

Lind† insists, with great force, on the danger incurred by passing the night in unhealthy localities. After men-

* Essai Politique sur la Nouvelle Espagne.

† An Essay on the Diseases incidental to Europeans in Hot Climates, etc. London, 1778, p. 215.

tioning other instances, he relates that of the Phœnix ship-of-war, which is so much to the point that I quote his remarks in full.

"In a voyage to the coast of Guinea, performed in the year 1776, by the Phœnix ship-of-war of forty guns, the officers and ship's company were perfectly healthy till, on their return home, they touched at the Island of St. Thomas. Here the captain unfortunately went on shore to spend a few days in a house belonging to the Portuguese governor of that island. This happened during the rainy, or sickly season. In the same house were lodged the captain's brother, the surgeon of the ship, some midshipmen, and the captain's servant. But, in a few days after their being on shore, the captain, his brother, the surgeon, and every one, to the number of seven, who had slept in that house, were taken ill, and all of them died except one, who returned to England in a very ill state of health. The ship lay at anchor there twenty-seven days; during which time three midshipmen, five men, and a boy remained on shore for twelve nights to guard the water-casks, under pretence that the islanders would steal them. At that island only those who slept on shore were taken ill, and no other man of the ship's company was seized with any distemper during their stay there, or during the voyage. If we except these unfortunate persons, only one man died through the whole of that time, and he was killed by an accidental blow on the head.

"None of those who slept on shore escaped the sickness, and of them, only three survived it: one midshipman, who has ever since been in a cachectic state, for which he was a patient in Haslar Hospital; a seaman in the same condition, who has been twice under my care; and a mulatto, one of the captain's cooks. * * * * *

"While the Phœnix continued in this place, twenty or thirty of her men went daily on shore; some rambled

about the island, hunting and shooting, others were busy in bartering for provisions, washing linen, and other necessary employments, so that almost all that ship's company, consisting of two hundred and eighty men, were, in their turns, ashore upon the island in the daytime, not one of whom who returned to the ship at night were taken ill or suffered the slightest indisposition."

Sir Gilbert Blane* also lays great stress on the point that the men employed in getting water and wood should so manage as not on any account to stay on shore all night.

I have always noticed, when being in malarious districts, that the men on guard during the night were much more liable to attacks of fever than those who remained in their quarters. Generally the disease appeared within twenty-four hours after the exposure. The same fact was apparent in the Peninsula during General McClellan's recent campaign.

4th. Malaria is capable of being moved by the wind from the places where it is formed to others which are healthy in themselves.

Lancisi† relates an incident which well illustrates this property. A party of thirty ladies and gentlemen were sailing on the Tiber, when the wind suddenly changed, so as to bring toward them the malarious emanations from a marsh in the neighborhood. Twenty-nine of the party were immediately attacked with fever.

There is scarcely a locality where malaria is produced in which the influence of the prevailing wind is not distinctly perceived. I have noticed very many instances of this fact, which is perfectly apparent to the dwellers in such

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* Observations on the Diseases of Seamen. London, 1800, third edition, p. 207.

† De Noxiis Paludum Effluviis. Roma, 1717, p. 29.

regions. Blane,* in considering the noxious effect of land air, says:—

"I have known a hundred yards in a road make a difference in the health of a ship at anchor, by her being under the lea of marshes in one situation and not in another. Where people at land are so situated as not to be exposed to the air of woods and marshes, but only to the sea air, they are equally healthy as at sea. There was a remarkable instance of this on a small island, called Pigeon Island, formerly described, where forty men were employed in making a battery, and they were there from June to December, which includes the most unhealthy time of the year, without a man dying and with very little sickness among them, though they worked hard, lived on salt provisions, and had their habitations entirely destroyed by the hurricane. During this time near one-half of the garrison of St. Lucia died, though in circumstances similar in every respect except the air of the place, which blew from woods and marshes."

Winds are useful in removing malaria from places in which it has accumulated. I have several times found that localities which immediately before heavy winds were very unhealthy became much less so afterward, doubtless in consequence of the dispersion of the noxious emanations.

5th. Malaria exhibits a great affinity for water.

This is a very interesting and important fact, for on it depends the exemption from malarious disease enjoyed by those of the crews of ships who stay on board their vessels.

This property of water to absorb malaria is undoubted, and has been referred to by almost every writer on the subject. Sir Gilbert Blane, Sir John Pringle, and others notice it. A situation even to leeward of a focus of malaria will suffer comparatively little from fevers if a sheet

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* Op. cit., p. 205.

of water intervenes. I have noticed several instances of this immunity. One reason, doubtless, why the night and early morning air is so prejudicial to health in malarious districts is that at such times the atmosphere contains more moisture, and consequently is loaded to a greater extent with malaria.

So strong is this attraction of malaria for water that instances have occurred in which fevers have been produced by drinking the water of marshes. The case recorded by M. Boudin, and quoted by Watson and Lévy, admits of no other interpretation. "In July, 1834, three hundred soldiers, all in good health, embarked on the same day in three transports at Bona and arrived together at Marseilles. They were exposed to the same atmospheric influences, and, with one essential difference, supplied with the same food and subjected to the same discipline. On board one of the vessels were one hundred and twenty soldiers; of these thirteen died of a destructive fever during the voyage, and eighty-eight more were taken to the military hospital of the lazaretto at Marseilles, presenting all the pathological characters proper to marshy situations. It appeared, upon inquiry, that the water furnished to the soldiers on board the affected ship had been taken, in the hurry of embarkation, from a marshy place near Bona, while the crew, not one of whom were attacked, were furnished with wholesome water. It was further ascertained that the nineteen soldiers who escaped the disease had purchased water from the crew, and had not partaken of the marsh water. Not a single soldier or sailor suffered in the other transports, which were supplied with pure water."

The water used by the troops during General McClellan's campaign in the Peninsula was derived from marshes, and doubtless contributed its full share to the production of the malarious fevers by which they were affected.

6th. Malaria has also an attraction for trees and other organic materials.

It is found perfectly practicable to prevent the access of malaria to dwellings by planting large trees or thick shrubbery in the immediate vicinity, between the originating point of the malaria and the house to be protected.

Musquito-nets fastened over the doors and windows at night, when through the extreme heat these are left open, also obstruct the malaria.

It has often happened that places previously healthy have been rendered subject to malarious affections by cutting down trees which interposed between them and marshes.

Rigaud de l'Isle* states that in consequence of the felling of the wood before Asterna, near the Pontine Marshes, Velletri was visited for three successive years by diseases, which made much greater havoc than usual throughout the whole country, and penetrated to many places which they had not previously been accustomed to reach. He says he has seen fishermen, who had built their huts near the canal which runs from Campo Salino to the sea, protected entirely from diseases of malarious origin by a wood, which screened them from the infected air of that morass.

7th. The first turning up of the soil leads to the production of malaria, but continued cultivation causes it to diminish in violence.

These facts are well understood in the West, and I have seen many instances of these truths. Habitations which have been healthy have become subject to malarious emanations immediately after breaking the sod of the prairie surrounding them. As the working of the land proceeded from year to year, they regained their previous healthy condition.

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* Op. cit., vol. ii. p. 122.

8th. As has been already intimated, malaria shows a marked proclivity to attack the members of the Caucasian race in preference to the individuals of other races, and therefore it is not necessary to dwell upon this point now, further than to urge the employment of negroes in those military field-labors which are attended with exposure to malarious effluvia.

9th. Malaria is prevented, in a great measure, from exercising its deleterious influence, by fires.

Cities have been rendered healthy for a season by conflagrations occurring within their limits; and men exposed to the night air in malarious regions make themselves secure from its influence by building large fires around their tents or bivouacs. I have often availed myself of this means of protection.

10th. Malarious diseases may be prevented by the administration of small quantities of quinine to those liable to contract them.

Sir Gilbert Blane* mentions this prophylactic influence of Peruvian bark, and urges the use of this medicine by those exposed to malaria.

Prof. W. H. Van Buren,† in an important paper, which deserves the widest circulation among our troops, for the good it is capable of effecting, enters at length into the consideration of this question. He says: "In April, 1840, the writer, then an assistant surgeon in the United States Army, was detached from the staff of the late General Worth at Tampa Bay, Florida, for duty at a military post in the interior, (Fort King,) where a serious outbreak of miasmatic disease had just occurred. The stock of quinine on hand was limited, and the supply uncertain, and every

* Op. cit., p. 209.

† Report of a Committee appointed, by Resolution of the Sanitary Commission, to prepare a Paper on the Use of Quinine as a Prophylactic against Malarious Diseases.

man at the post was having his turn of disease. To meet the emergency a quantity of quinine bitters was made in the following manner: the half of a barrel of whisky was drawn off into a second barrel, and they were both filled with the bark of the dog-wood and wild-cherry, obtained from the neighboring hummock, and dried in the sun. A few ounces of quinine were added to each barrel, with the dried peel of a dozen native oranges. From one to two ounces of this preparation were given to each man at the post, morning and evening, with the effect in a very short time of rendering the relapses of fever less frequent and milder in their character, lengthening the interval between the attacks, and in many instances preventing their occurrence entirely during its use."

I have frequently employed quinine with this object, and always with success. Throughout the unhealthy season of 1862 the troops generally, serving in malarious regions, were supplied by the medical department with a bitters made by dissolving quinine in whisky. The sulphate of cinchonia was finally substituted for the quinine with excellent results.

From this cursory statement of the laws and habits which influence malaria, it will be seen that to a very considerable extent we are enabled to provide against its ravages. Those having the control of troops should be instructed by the medical officers of the command in the knowledge of these matters, by attention to which sickness may often be prevented, and the efficiency of the army preserved.

Thus troops should be quartered or encamped as far as possible from the source of malaria.

Low situations should be avoided; barracks should be built with the first floor raised some distance above the ground, and tents in permanent encampments should be floored.

The night air should be as far as possible avoided. The men should not be called up, unnecessarily, before sunrise, and drills before breakfast should be discarded.

Stations for camps or barracks should be selected with reference to the prevailing winds, so as to be to the windward of all marshes or other sources of malaria.

If possible, stations should be selected so as to have an intervening sheet of water between any malarious region and the troops, and the dews of morning and evening should be avoided. Advantage should also be taken of the property of trees and other foliage to retain malaria. Tents should always be supplied, if possible, and the men should be instructed to close them at night when exposed to miasmatic emanations.

Fires should be built throughout the camp, unless military reasons prevent. This is a point of great importance.

Finally, troops subjected to the influence of malaria should be supplied with quinine or cinchonia as a prophylactic, in the dose of two grains of the former or four of the latter daily.

This concludes what we have to say relative to the constituents of the atmosphere and the extraneous matters which are found in it. The student of hygiene will find much in the whole subject requiring still further investigation than has yet been given to it, and it is commended to him for careful study and original research.

CHAPTER III.

PHYSICAL PROPERTIES OF THE ATMOSPHERE.

THERE are still other points to be considered in connection with the atmosphere, which have an important bearing upon the hygienic condition of mankind, and these are its density, and the power it possesses of being put in motion, whereby winds are produced.

DENSITY.—By the invention of the barometer in 1643, Torrecelli, a pupil of Galileo, demonstrated the weight of the atmosphere. He found that by filling a glass tube with mercury and inverting it over a cup containing the same metal that the column was sustained at about thirty inches in height. Subsequently Pascal ascertained that a column of water, thirty-three feet in height, was also supported by the pressure of the atmosphere.

At the level of the sea the atmosphere exerts a pressure of nearly fifteen pounds to the square inch. As we ascend from this level, the weight of the atmosphere becomes less, and the mercury in the barometer progressively falls. On the contrary, as we descend into mines, the mercury rises, in consequence of the increased height and weight of the atmosphere. Aside from altitude, there are other circumstances which increase or diminish the density of the atmosphere. The barometer has been found to oscillate with perfect regularity, according to the period of the day, being higher in the morning and evening than the middle of the day. These variations are especially marked in low latitudes. As we approach the poles, they become less and less extensive, until at 70° they are scarcely perceptible.

In addition to these daily regular oscillations, there are others which are accidental—that is, dependent upon transient and uncertain causes. These are much more extensive than the diurnal variations, which may be considered as corresponding to the oceanic tides, while the others represent storms. These last are much more extensive in polar than in tropical regions. They are doubtless due, in the main, to the condensation or rarefaction of the atmosphere, through the action of winds, and to the presence of a greater or less amount of aqueous vapor.

The degree of density of the atmosphere is not without considerable influence on the well-being of man. From the experience of those who have ascended to great heights we are enabled to form an idea of how important it is to his existence that a certain amount of pressure should be communicated to his body. Difficulty of breathing, hemorrhages from the nose and mouth, vertigo, and other alarming symptoms being produced in those who have attained to great altitudes. At the same time the influence of habit in this respect is very great, for we find large cities situated at heights which could not be endured, without some inconvenience, by those not accustomed to them. The entire pressure of the atmosphere on the surface of the human body, if we estimate the superficial area of a full-grown man at two thousand square inches, is about thirty thousand pounds at the level of the sea. For every inch of depression of the barometer a thousand pounds of pressure are removed from his body. Altitudes have been reached by man at which the mercury in the barometer stands at only thirteen inches, and consequently seventeen thousand pounds weight are removed from his body at such heights.

On descending to extreme depths in water, by means of diving-bells as they were formerly constructed, the pressure of the contained atmosphere was very much increased.

Blood has been known to flow from the lungs, nostrils, and ears, and the tympanum of the ear has been ruptured. Habit here also exerted its influence, and the greatly increased density came to be borne by the workmen without inconvenience. M. Triger,* in the course of some mining operations, found it necessary to subject the workmen to a pressure of about three atmospheres. Though pain and inconvenience were felt at first, they soon became used to the new state of things.

Although it is not probable that an increase in the density of the atmosphere, within the limits of the ordinary range of the barometer, could seriously affect the hygienic condition of man, there is strong reason for supposing that this instrument is capable of affording valuable indications relative to the presence of gases or vapors prejudicial to health. Several years since Dr. Prout† noticed a small but sensible increase in the weight of the air during the prevalence of cholera. This continued for six weeks, when circumstances occurred to suspend his observations. Dr. Prout did not attribute the cholera to the mere increase in the density of the atmosphere, but thought that the barometer indicated the existence of a deleterious and heavy gaseous element in the lower strata of the air.

Dr. R. D. Thomson‡ examined into the density of the air in London during the prevalence of cholera, and obtained results analogous to those arrived at by Dr. Prout. He found that, as the mean of a number of observations, the weight of a cubic foot of air in August, 1854, when cholera prevailed, was 525·6 grains, whereas in August, 1855, when there was no cholera, it was 523·5 grains.

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* Influence de l'Air comprimé sur la Santé. Ann. d'Hygiène, 1845, tome xxxiii. p. 463.

† On the Influence of Physical Agents on Life, by W. F. Edwards, M.D., F.R.S., etc., p. 220, note.

‡ On the Condition of the Atmosphere during Cholera. Chemist, 1856, vol. iii. p. 121.

I have had no opportunity of observing the density of the atmosphere during the prevalence of cholera, as I was without a barometer or other means for determining the weight of the air, while the three epidemics of the disease, which I have witnessed, lasted. From a careful search of the meteorological records of the Surgeon-General's office, I find that there was a very considerable rise in the barometer, at the several posts and garrisons, while cholera was prevailing in 1849, amounting to as much as 0·060 of an inch when compared with the corresponding month of the previous year, when there was no cholera. This increased density was well marked in subsequent years when cholera visited the military stations.

WINDS.—The influence of winds upon health is very great. Through the action of the almost constant currents, which are excited by the varying density of the atmosphere, the air, which has become contaminated by organic and other exhalations, is removed, to make way for that which is fresh and contains the normal amount of oxygen. Thus stagnation is prevented, and the injurious matters which have accumulated in any place are diffused throughout an immense medium, and so diluted that they lose their noxious properties.

On the other hand, winds serve to transport malarious emanations to a great distance, and are thus fruitful causes of disease. This fact should not be lost sight of in selecting sites for barracks, hospitals, and encampments, which should always, if possible, be placed so that the prevailing winds will not pass over marsh, river, or other supposed focus of malaria in the vicinity before reaching them.

Winds are more or less modified in their character according to the direction from which they come. Throughout the greater part of the United States an east wind generally brings moisture with it, and is therefore liable to induce catarrhs and rheumatic affections. In Texas a

north wind, or a "norther," as it is called, causes a great reduction in the temperature. On one occasion, in this State, a party of soldiers and teamsters left one of the forts in the morning to procure wood from a forest a few miles distant. The day was warm, and they did not even take their coats with them. Before night a norther came up, and several of the party perished with cold before they could reach the garrison.

In Kansas, and throughout the sandy region of country known as the American Desert, during the summer season the wind that comes from the south is extremely hot, arid, and enervating. Diarrhœa and dysentery are prevalent during its continuance, which is generally for two or three weeks in midsummer.

In Italy, and along the northern shore of the Mediterranean, a wind of a very debilitating and relaxing character, coming from the south-southeast, called the sirocco, prevails periodically in early spring, lasting for from fifteen to twenty days. During its continuance those who are at all sensitive to its influence keep the house. Its effects upon animal life are extremely depressing, and even plants droop and wither under its action.

The simoom is still more noxious. It is a wind of the deserts of Asia and Africa, not periodical, and lasting but for a few minutes at a time. Animals of all kinds instinctively fly for shelter at its approach, or crouch to the earth till it has passed over. It is irrespirable, and if inhaled only to a slight extent, produces asthma and excessive debility, which last sometimes for several months. This wind is not only hot and arid, but carries with it a fine sand, which adds to its disagreeable effects. It is more than probable that the simoom owes much of its deleterious character to the presence of sulphurous acid.

There are other winds possessing special characteristics, particular reference to which will be found in most works

on meteorology and those devoted to the consideration of climate. In fact, the whole subject of aerial currents has a most important bearing upon health, and is worthy of more extended notice than can be given to it in a general treatise.

CHAPTER IV.

TEMPERATURE.

Man is capable of enduring great extremes of heat and cold. In the polar regions, where the mean temperature for the year is as low as 3° Fahrenheit, and where the thermometer for days together is frequently 50° below this point, human beings are found enjoying life; subsisting entirely on animal food, and dwelling in huts made of the snow by which they are ever surrounded. Likewise in the tropics, where the mean annual temperature is in many places as high as 85° Fahrenheit, and where the mercury in the shade often indicates a heat of 120°, races of men live and flourish.

It is not to be denied, however, that the best specimens of the human race are not found in climates where these extreme ranges of temperature prevail. A mean annual temperature of from 40° to 60° Fahrenheit is that under which man physically and mentally attains the greatest degree of vigor, and which is most conducive to health and long life.

The ability of man to exist, with comparative comfort, under extreme depression of temperature, is very much influenced by the degree of stillness in the air. Thus, in the

arctic regions a temperature of —60° or —70° Fahrenheit can be borne if the air is at rest, whereas if a strong wind is blowing a far higher degree of heat is unendurable. The same rule holds good with regard to extremely high ranges of temperature, warm air in motion being much more oppressive than air of the same temperature in a state of repose. This fact was referred to when the subject of winds was under consideration.

The ability to resist low temperature is very much in accordance with the character of the food taken into the stomach. The hydrocarbons, such as the fats and oils, are most effectual in maintaining the heat of the body when it is subjected to intense cold; alcoholic liquors have also the same power, when taken in proper quantity. In very hot climates the inhabitants live almost entirely on fruit and carbohydrates, avoiding the use of fatty substances and animal food.

The degree of dryness of the air is also a point to be considered in connection with high and low temperatures, each being more readily endured when the atmosphere is dry. Thus, a heat of 350° has been tolerated for short periods in a perfectly dry atmosphere, as in the case of the workmen of Sir F. Chantrey, the sculptor, who were accustomed to enter furnaces heated to this point.* Arctic voyagers have noticed their ability to resist extremely low temperatures when the air was dry, which they could not combat when it contained much moisture.

The effect of extreme depression of temperature is to produce a torpor of the mental and physical faculties, which, if yielded to, results in death before congelation of the tissues has taken place. Captain Cook relates the particulars of an excursion of Sir Joseph Banks, Dr. Solander, and nine others over the hills of Terra del Fuego, which

* Carpenter's Principles of Human Physiology. Am. ed., p. 620.

afford a very striking illustration of this effect of extreme cold. Dr. Solander was very well acquainted with the consequences which result to the animal body from extreme depression of temperature, and cautioned his companions against yielding to the intense desire to sleep, with which they were liable to be affected, and urged them to continue in motion. "Whoever sits down will sleep," said he, "and whoever sleeps will wake no more." He himself was the first to experience this irresistible inclination to rest and sleep, and, notwithstanding his knowledge of the consequences that would ensue, he entreated his companions to allow him to lie down. They knowing, from the information he had given them, the fate to which he would be subjected, urged him forward, but becoming exhausted themselves they were finally obliged to leave him behind with two black servants, who had also become drowsy. Dr. Solander was, however, roused, though with great difficulty, and carried to a fire which some of the men had succeeded in kindling. Though he had slept but five minutes, he very narrowly escaped death, and for a considerable period afterward was deprived of the use of his limbs. The two negro men perished.*

Many other instances similar to the above will be found recorded by travellers and historians. Thus Charles XII. lost two thousand men in the bleak and barren plains of Ukraine. Napoleon, who entered Russia with an army of five hundred thousand men, crossed the boundary on his return with scarcely thirty thousand. The great majority of the remainder had perished with cold.

It has several times occurred to me to notice this effect of cold in producing numbness and drowsiness. On one occasion I was myself nearly overcome by an intense desire to sleep produced by a sudden change in temperature,

* Cyclopedia of Practical Medicine, article *Cold*, vol. i. p. 454.

by which the thermometer fell in about two hours from 52° to 22° Fahrenheit. I was crossing the mountain ridge between Ceboletta and Covero, in New Mexico, and if I had had much farther to go should probably have succumbed. As it was, I reached a rancho in time to be relieved, though it was several minutes before I could speak. The sensations experienced were far from being disagreeable, and with all these was a feeling of recklessness of consequences that made it a matter of indifference whether life was preserved or not.

The influence of cold is very great in giving rise to disease. One of the chief causes of tetanus is cold conjoined with moisture. Idiopathic tetanus is often produced by exposure to cold winds or by lying down on the cold ground. Traumatic tetanus likewise is frequently superinduced, by the wounded in battle being obliged to lie during the night on the field, exposed to the dews and reduction of temperature which ensue. Certainly the very great majority of cases of tetanus which have come under my observation, during the present rebellion, have been caused by exposure to these influences. A frog can at any time be thrown into a tetanoid state by placing it in water eight or ten degrees lower in temperature than the medium in which it was, before trying the experiment.

By its action in depressing the vital power and constringing the blood-vessels near the surface, cold gives rise to internal congestions and inflammations. Apoplexy is more frequent, for this reason, during winter than in summer. Bronchitis, pneumonia, diarrhoea, and rheumatism are produced in this way.

Cold also produces an effect upon the organism when one part of the body is reduced in temperature below the rest. Thus cold hands or feet produce, probably through the nervous system, inflammations of internal viscera, and a draught of air striking on an exposed part of the body

will give rise to like results. When the body is overheated *and commencing to cool*, a drink of cold water may produce instant death; but if the heat of the body is still at its height, no injurious consequences follow. After severe exercise, from which the temperature of the body has become elevated, we should not therefore stop to rest before taking a drink of cold water or plunging into a cold bath. If either is indulged in, it should be before the cooling process has commenced.

The sickness and mortality of the United States forces have, since the commencement of the rebellion, been much less during the winter months of the year than during those of summer. These facts, in regard to the sickness rates, are shown in the accompanying table, prepared by Assistant Surgeon J. J. Woodward, United States Army, from the data in the Surgeon-General's office. It relates but to five of the armies, and is based upon returns from about three hundred thousand troops. The results are certainly different from those obtained in European countries.

Table showing the Monthly Ratios of all Diseases per 1000 *of mean strength.*

	1861.						1862.					
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Army of Potomac	479·	428·	312·	280·	276·	248·	211·	189·	160·	284·	261·	314·
Army in Western Virginia	227·	278·	262·	318·	267·	250·	218·	216·	246·	231·	168·	210·
South Carolina Expedition				271·	346·	358·	292·	216·	195·	209·	268·	262·
Troops in Florida	540·	448·	392·	238·	158·	105·	112.	159·	220·	256·	208·	259·
Troops in Kansas	208·	249·	280·	222·	178·	151·	188·	154·	150·	108·	68·	104·

One of the principal effects of extreme cold is to cause congelation of the tissues. The natural temperature of the blood at the center of circulation is about 98° Fahrenheit, and this cannot be reduced more than a very few degrees without death being the result. Extreme cold may, however, act only upon those parts which are farthest from the center of the body, as the hands and feet, the ears and nose. In certain diseases attended with deficient power of the circulation, as in typhoid fever and scurvy, congelation is liable to occur from the effects of a temperature which would not give rise to it in the healthy subject. I have witnessed several instances of this fact, and many are recorded as occurring in the Crimean war. Too much care cannot be taken to maintain the heat of the body in such diseases during the prevalence of low temperatures.

The consequences of extremely high temperatures are no less well marked than those we have considered. When continued for any great length of time, diseases of the liver, diarrhœa, dysentery, and fevers are induced. The effects of the direct rays of the sun in hot weather are often of a very serious character. Troops should always, as much as possible, be sheltered from their influence. Sun-stroke, by which congestion of the brain and a peculiar effect upon this organ and the other parts of the nervous system are produced, may be prevented by the use of suitable covering for the head. The turban of the zouaves is undoubtedly the best in this respect which has been devised, the thick white folds of linen or muslin serving as a great protection from the sun's rays. A wet cloth, folded and placed in the crown of the cap, is also an excellent means of preventing the access to the head of the excessive heat of the vertical sun.

Temperature has also great influence over the production of malarious and certain other zymotic diseases. A temperature of 32° Fahrenheit destroys the malarial poison

and that which gives rise to yellow fever, but does not appear to control the contagious principle which causes the exanthemata.

Those races which live in hot climates are always of dark complexion, and dark hair and eyes. They are generally more delicately organized than the races which inhabit cold or temperate regions.

One of the greatest cares of the medical officer of a hospital is the regulation of the temperature to which his patients are to be subjected. The sick and feeble will not bear the low temperature which, to those in good condition, acts as a healthful stimulant. The various means of providing the proper amount of heat will be fully considered hereafter, but it is proper now to insist upon the utmost attention being given to the maintenance of a standard temperature in the wards. Thermometers should be placed, in large wards, at intervals of every thirty feet, and the heat in winter should be maintained, as nearly as possible, at from 62° to 66° of Fahrenheit. In summer the matter is not so much under control, but, by judicious ventilation, the air can always in hot days be kept several degrees below the temperature of the external atmosphere.

CHAPTER V.

LIGHT.

For the full development of most animal and vegetable forms light is essential. Though it is true that many species of both kingdoms exist without ever being subjected to the influence of a single ray of light, they are of low orders, and scarcely constitute exceptions to the rule.

Plants deprived of the influence of light become blanched and stunted; animals are similarly affected. The tadpole, which, under normal circumstances, develops into the frog, when subjected to darkness, does not undergo the transformation with the same degree of promptness, and may even be thereby entirely prevented from becoming a perfect reptile.

Edwards,* who instituted experiments relative to this point, came to the conclusion that the action of light is to develop the different parts of the body in that just proportion which characterizes the type of the species, for he found that growth was not prevented, the tadpoles deprived of light continuing to increase in size, but without undergoing change of form.

I have several times repeated his experiments, and always with analogous results. On one occasion I prevented, for one hundred and twenty-five days, the development of a tadpole, by confining it in a vessel to which the rays of light had no access. On placing it in a receptacle open to the light, the transformation was at once commenced, and was effected in fifteen days.

The influence of light upon other animals is also well marked. It is almost invariably the case that those parts of the bodies of animals nearest the ground, and, consequently, least under the influence of light, are white or colorless. The brilliant colors which belong to the plants and animals of almost every kind found in the tropics are doubtless due, in part at least, to the influence of light.

In plants light decomposes carbonic acid, and is the principal agent in the formation of chlorophyll. In man it is through its influence that the pigmentum nigrum of the skin is produced. That it is not formed through the action of heat, is, as Lévy observes, proven by the fact that the

* The Influence of Physical Agents on Life, p. 127.

Greenlanders, the Esquimaux, and other arctic inhabitants are of dark skin and hair.

The importance of light in a hygienic point of view can scarcely be overestimated. Individuals deprived of it from an early age, as are the denizens of courts and cellars, are generally of low vital power. The offspring of such are frequently deformed, and are always weak and puny. From the observations of those who have given attention to this subject, there appears to be no doubt that scrofula is often produced in children by the deprivation of the solar rays.

In miners and their families the effects of insufficient light are more fully exhibited than in any other class of people. Living sometimes almost entirely in obscurity only slightly dispelled by artificial illumination, they are thin, extremely subject to deformities, and completely etiolated.

Etiolation is well described by Riembault.* According to this author, it is characterized by a diminution of the fibrin, the albumen, and the red globules of the blood, while the water is augmented in quantity. The face is discolored, and acquires a tint analogous to that of yellow wax; the veins of the skin are no longer to be perceived, even in those parts where they are largest and most numerous; the pulse is very frequent, beating at the rate of from 90 to 100 per minute without increasing the heat of the skin; there are palpitations and a bellows murmur in the heart and carotids. The prostration of the forces of life is extreme, and it is distressing to see the miserable beings thus affected scarcely capable of sustaining their lean and prematurely decrepit bodies. They are extremely subject to dropsy, to petechiæ, and to passive hemorrhages.

* Hygiène des Ouvriers Mineurs, etc. Paris, 1861, p. 179.

These effects are, many of them, seen, though less strongly manifested, in the inmates of wards and sick chambers from which the light is carefully excluded. I shall never forget the appearance presented by the sick of a regiment I inspected, about a year since, in Western Virginia. They were crowded into a small room, from which the light was shut out by blinds of India-rubber cloth. Pale, exsanguined, ghost-like looking forms, they seemed to be scarcely mortal. Convalescence was almost impossible; and doubtless many of them died who, had they been subjected to the operation of the simplest laws of nature, would have recovered.

On the other hand, it is to be recollected that an excessive amount of light is not only injurious in certain diseases, but is also capable of inducing disordered action in persons who are in a good state of health. Soldiers exposed to the reflection of the sun's rays from the sand or from snow, suffer to a great extent from eye diseases. I have seen a number of cases of temporary blindness produced from both these causes, and many are on record to the same effect, noticed by other observers. Thus Lévy* mentions that in 1819 the Swiss soldiers in garrison at Lyons had many of their number affected with hemeralopia, accompanied with nervous symptoms, such as nausea, vomiting, etc., due to drilling under a hot sun. The Greeks, as related by Xenophon, suffered severely by the reflection of the light from the snow as they crossed the mountains of Armenia, many of them losing their sight. Voyagers to the polar regions all mention the snow-blindness by which not only their own men were affected, but the natives also.

Purulent conjunctivitis and other inflammatory affections of the eyes are caused by excessive light, but the

* Op. cit., p. 352.

most common morbid result of exposure to intense light is amaurosis, which may be either temporary, as is generally the case, or permanent, resulting from congestion or inflammation of the nervous apparatus of the eye. Such effects may be caused either by the direct or reflected rays of the sun, by a flash of electricity passing near the individual, or by intense artificial light. I know a child who was rendered permanently amaurotic by looking intently at a bright object while she was having her photograph taken.

In the management of diseases, light can be often employed with advantage, and often must be, to a great extent, shut off from access to the patient.

In chlorosis, scrofula, phthisis, and, in general, all diseases characterized by deficiency of vital power, light should not be debarred. In convalescence from almost all diseases it acts, unless too intense or too long continued, as a most healthful stimulant, both to the nervous and physical systems. The evil effects of keeping such patients in obscurity are frequently very decidedly shown, and cannot be too carefully guarded against by the physician. The delirium and weakness, which are by no means seldom met with in convalescents kept in darkness, disappear like magic when the rays of the sun are allowed to enter the chamber. I think I have noticed that wounds heal with greater rapidity when the light is allowed to reach them than when they are kept continually covered. Ribes* makes a similar statement.

In active delirium, in inflammation of the brain, and in all diseases attended with great nervous excitement, light should be excluded from the patient. Small-pox also seems to progress more favorably in darkness, and certainly exposure of the pustules to the light appears to be the cause of the permanent scars which remain after convalescence.

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* Traité d'Hygiène Thérapeutique, etc. Paris, 1860, p. 207.

CHAPTER VI.

ELECTRICITY.

The study of the therapeutical and physiological action of electricity has been very much advanced by the labors of Galvani, Volta, Matteucci, Louget, Bernard, Du Bois-Reymond and many others, but its etiological influence is by no means as well understood, and we are at this day, to a great extent, ignorant of the part played by this agent in the production of disease, or in the preservation of health.

But we are not altogether without information on these points. We know that electricity is the cause of the formation of the ozone found in the atmosphere, and, as we have seen, this principle exercises an important influence over human health. We know, too, that rain and storms are produced through its action, and that they are powerful hygienic and pathological factors. But these are not primary instances of its influence, and beyond a few scattered facts, which indicate that it is capable of affecting the nervous system, that certain diseases have been occasionally cured by it, and that death results from a powerful shock, we know little or nothing relative to the connection of atmospheric electricity with the sanitary condition of man.

I have known weak and nervous women to be hysterically affected at the approach of a thunder-storm; but whether this was due to fright or to any action of the electricity on the nervous system, is difficult to decide.

It is probable that the rapid passage of electricity from

the body is productive of languor and *malaise*. We know that on a clear, cold, and dry morning, when the air is a bad conductor, the animal spirits are high, and that there is a general feeling of energy and strength; but even here it is by no means certain that the meteorological agents associated with electricity are not the prime causes of the well-being of the organism.

It is also stated* that at the approach of a thunder-storm dyspnœa, due to emphysema and heart disease, gets worse; patients suffering from chronic rheumatism and neuralgia complain of increased pain; paroxysms of intermittent fever anticipate the usual time of occurrence; the symptoms attendant upon certain acute diseases, as pneumonia, grow more alarming, and that in fatal cases death will arrive earlier in stormy weather than might else have been anticipated. Some of these assumed consequences of the approach of thunder-storms are extremely problematical, and all, even if resulting from such a cause, admit of other explanation, with fully as much probability.

The experiments of Achard† appear to show that electricity promotes the decomposition of organic substances. This observer electrified pieces of boiled beef and veal, and found that they commenced to putrefy much sooner than similar pieces placed under otherwise similar conditions.

Van Marum found that the amount of insensible perspiration was very considerably lessened by electricity.

Through the action of the atmospheric electric shock individuals who had been deprived of speech and sight have had these faculties restored to them; and Dr. John Le Conte‡ mentions the case of a negro woman, seventy

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* A Treatise on Medical Electricity, etc., by J. Althaus, M.D. London, 1859, p. 347.

† Quoted by the editor of the English edition of Edwards on the Influence of Physical Agents, etc., p. 195.

‡ New York Journal of Medicine, 1844.

years of age, who had not menstruated for twenty years, but who, after having been struck by lightning, had her menses restored and rendered regular, for more than a year afterward.

As has been said, the therapeutics of electricity have been well studied, and the amount of our knowledge on this point is extensive. Neither this, however, nor the many beautiful and important observations which have been made in regard to the purely physiological relations of this agent, come within the scope of this treatise.

CHAPTER VII.

WATER.

WATER in a state of vapor, as it exists in the atmosphere, has already engaged our attention, and we have now to consider it as a substance necessary to life. Under this head its relations are very numerous. The various kinds of water; the means of examining as to its purity; the several methods in use for freeing it of matters which render it unfit for ingestion or for the other purposes of every-day life; the diseases which are induced by impure water, etc. are subjects of so much importance, in a sanitary point of view, that we shall not hesitate to enter into their full consideration.

Water is a compound of hydrogen and oxygen, united in the proportion of eight parts of the former to one of the latter by weight, or one volume of oxygen to two volumes of hydrogen by measure. Its formula is HO, and it is therefore a protoxide of hydrogen. It constitutes about

three-fourths of the surface of the earth, and the greater part of the body of man and other animals. Some vegetables contain as much as ninety-five per cent. of water. When pure, it is without taste or odor; its freezing point is at 32° Fahrenheit, though it may, when kept perfectly still, be cooled to a much lower temperature without solidifying. At the level of the sea it boils at 212° Fahrenheit.

Water is not always of the same character. It contains, according to the source whence it is derived, certain substances dissolved in it, and frequently microscopic organisms of various kinds. It is never found in nature in a state of absolute purity. All water contains atmospheric air in solution, which is driven off by ebullition, but which is reabsorbed when the water is agitated with it.

Sea Water.—The water of the ocean is unfit for drinking purposes on account of the large quantity of salt and other mineral substances which it contains. Its taste is salt, acrid, and bitter. Its exact composition varies with the latitude and the depth at which it is collected. In the polar regions it contains less mineral constituents than elsewhere, owing to the great amount of ice which is constantly being cast into it. The water of the Mediterranean Sea, on the contrary, holds in solution a greater quantity of mineral substances than that of any other ocean, except the Atlantic Ocean at the equator. According to Marcet, the water of the middle of the Atlantic Ocean contains, in 1000 parts by weight—

Chloride of sodium	26·600
Chloride of magnesium	5·154
Chloride of calcium	1·232
Sulphate of soda	4·660
Total solid matter	37·646

In addition, there are present bromide of sodium and magnesium, and a small quantity of organic matter. Though

there can scarcely be a doubt of the presence of iodine in sea water, chemical analysis has so far failed to detect it. Recent analyses would appear to determine the existence of silver, lead, and copper, in very small quantity, in the water of the ocean.

By distillation, and subsequent agitation with atmospheric air, sea water is rendered fit for drinking; and most vessels intended for carrying passengers are furnished with apparatus for freeing salt water from its impurities.

The temperature of the water of the ocean is far more equable than that of the superimposed atmosphere. Thus, in the tropics, where the thermometer may indicate at night 100° of Fahrenheit, and where in the direct rays of the sun it stands much higher, the temperature of the sea rarely rises above 80°. In temperate climates there is scarcely any difference in the temperature of the ocean in winter and summer, it being about 60° throughout the year.

Rain Water.—The vapor which is being constantly given off from the surface of the sea and rivers is condensed in the atmosphere, and falls to the earth as rain. Rain water is nearly pure; it contains, however, traces of organic matter, nitric acid, and ammonia, which it has derived from the atmosphere in its passage through it. Snow and hail, which are modified forms of rain water, possess similar qualities when melted. Mr. J. T. May* has shown, however, that snow contains a much larger quantity of ammonia than rain; and M. Boussingault,† that the water of city fogs is especially rich in this substance, a fact which sufficiently accounts for the irritating effects of such fogs on the organs of respiration, even if we deny the agency of ozone in producing this result.

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* On the Quantity of Ammonia and Nitric Acid in Rain Water. Chemist, 1857, vol. iv. p. 362.

† Comptes Rendus, February 6th, 1854.

Rain water is sweet and soft, and, when filtered from the impurities attracted from the atmosphere, colorless. It is therefore entirely fit for the purposes of drinking and washing.

Spring and well waters are impregnated with the soluble materials present in the strata through which they pass, and, accordingly, are often unfit for the ordinary purposes of life. The temperature is variable, though generally they are colder than other waters. Hot springs are, however, found in various parts of the world with temperatures ranging as high as 212° Fahrenheit.

Mineral springs are those the water of which contains notable proportions of mineral substances, such as iron, sulphur, magnesia, etc.

Spring water is often exceedingly pure and soft, though generally it contains lime and chlorides. These, however, do not, unless in very large quantity, militate against the use of spring water for drinking or washing.

River water is similar in many respects to spring water. It is often, however, contaminated with earth and sand, and also with organic matters derived from decaying vegetation and animal remains, the sewerage of cities, the refuse of manufactories, etc. River water is that which is generally supplied to cities, and also that which is usually most at the command of armies.

After heavy rains, or the melting of ice and snow, producing floods, river water is more apt to be loaded with earthy matters than when a low stage of water prevails, though, so far as the other impurities are concerned, these causes produce an improvement in its quality.

Stagnant water is, from the amount of organic matter which it holds in solution, not suited for drinking purposes, although it is frequently sweet and limpid. It should not therefore be so used as long as it is possible to obtain running water.

The water of marshes, ditches, canals, ponds, etc. all come under this head.

Having thus briefly enumerated the various kinds of water which are placed at the disposal of man, we come to the consideration of them in their hygienic relations. They are properly arranged into four groups: 1st, drinking waters; 2d, mineral waters; 3d, bathing waters; and 4th, washing waters.

DRINKING WATERS.—The only waters which are fit for drinking (excluding from this head the mineral waters, which are properly medicinal) are rain water, river water, and spring or well water.

A water to be suitable for this purpose should be free from any considerable quantity of organic or mineral constituents, and consequently colorless, and without any peculiar odor or taste. At 30° Fahrenheit and 30 inches of the barometer one hundred volumes of water contain about five volumes of air. The large quantity of water imbibed by an individual renders it a matter of great importance that substances of a deleterious character should not be present, or if they are, that they should be capable of being readily removed.

The army surgeon is frequently called upon to decide as to the fitness of water for the use of the troops, both for drinking and washing, and he should therefore be enabled to make a correct decision, and to suggest the means that may be available for the purification of such water as requires it. For these purposes very few appliances, in the way of apparatus and tests, are required.

All waters of the class under consideration, except rain water, contain lime and chlorides, and frequently other mineral substances, in solution. The lime is in combination with either carbonic or sulphuric acid, or both, and the chlorides are those of sodium, magnesium, or potassium. It is probable that so far from being injurious, these

matters, when not present in too great a proportion, are rather beneficial to the organism than otherwise. When, however, they exist in large quantity, they produce intestinal disturbance, and the lime salts undoubtedly give rise to calculi in the kidneys or bladder. River water is also often, as has been said, loaded with other impurities. Some of these are of such a character as to cause serious diseases in those who use the water in which they are found, and are sometimes so abundant as to be destructive to the fish living in them. It is well known that the white-bait, a very delicate fish inhabiting the Thames, is not found above Greenwich, on account of the noxious character of the water, due to the influx from the sewers of London. The fish of the Schuylkill River, above the falls, have been almost entirely destroyed by the water pumped into it from the coal mines situated along its banks or those of its tributaries.

The earthy matters which are so abundant in some of our western river waters almost invariably cause diarrhœa in those who are unaccustomed to their use, though this effect gradually ceases to be produced if the drinking of the water is persisted in. I have very frequently known the water of the Mississippi, the Missouri, the Kansas, and the Rio Grande give rise to severe diarrhœa, continuing for several weeks, and occasionally terminating in ulceration and death. Even in persons who can at ordinary times drink the water of these rivers with impunity, frequent intestinal discharges are produced when floods have caused an increased quantity of earthy matters to be held in suspension.

In the selection of sites for camps, hospitals, barracks, etc., the medical officer is often consulted with reference to the character of the water. In the field it is frequently impossible to camp the troops in positions which afford good drinking water, but in the location of hospitals and

permanent works this end can generally be insured. It should be recollected that no one sanitary element is of more importance than the one under consideration. I have known stations selected without the least regard to the character of the water; where this was so loaded with saline matters that the men were almost constantly affected with diarrhœa, or so contaminated with organic substances that putrefaction commenced in a few hours after it was brought to the quarters.

River and spring water almost always contains an appreciable quantity of sulphates. In the water supply of towns, where the water is conveyed in part through leaden pipes, this fact is one of very great importance, as on it depends the property which such water possesses, of not being rendered poisonous by its action on the lead. When pure water, recently boiled, is placed in contact with lead, no action takes place; but if the water has been exposed a short time to the air, from which it absorbs oxygen and carbonic acid, and is then placed in a leaden vessel, it is not long before a white film, consisting of carbonate and hydrated oxide of lead, forms on the surface of the metal. This becomes detached, and falls to the bottom of the vessel. It is highly poisonous. When, however, the water contains sulphuric acid, this substance forms an adherent coating of sulphate of lead, and prevents any further chemical action. The purer the water, the more liable is it to become contaminated with lead, when kept in cisterns or transmitted through pipes of this metal. Rain water not only contains oxygen and carbonic acid, but also nitric acid, which forms nitrate of lead, a salt soluble in the water, and not therefore to be detected by any but a chemical examination. Rain water accordingly should never be kept in cisterns lined with lead.

The quantity of lead necessary to produce poisonous effects

is very small. In the Claremont poisoning, Dr. Hofmann* found but one grain of lead to the gallon of water, and much less than this quantity would in time produce injurious results to the health of those using water thus contaminated. The Claremont water contained five grains of saline matter to the gallon of water; but one-half of this was chloride of sodium.

Christison† refers to the fact that lead colic was almost unknown in Amsterdam till the inhabitants began to substitute lead roofs for tiles, when a violent epidemic of the disease occurred, and committed great ravages.

With reference to the action of water upon lead, I have instituted some experiments which fully corroborate those of other observers. Thus, I took some rain water collected directly in a wooden vessel, and placed it in a bright leaden jar. Upon testing a portion of it twenty minutes afterward by passing a current of sulphuretted hydrogen through it, a brown precipitate of sulphuret of lead was formed. One pint, after the water had been in the vessel six hours, contained one-seventh of a grain of lead—a proportion amply sufficient to have produced the most serious results if the water in which it existed had been used as a drink for a few weeks.

Another portion of rain water in which, to each gallon, five grains of sulphate of magnesia were dissolved, was next placed in the vessel. Upon examining it half an hour afterward, no precipitate was produced by sulphuretted hydrogen, but a white coating had already commenced to form around the surface of the metal. It was retained in contact with the lead for thirty days, without giving evidence of the presence of lead.

To a third portion of rain water five grains of sulphate

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* Taylor on Poisons. Am. ed., p. 452.

† Treatise on Poisons, p. 407.

of magnesia and five of chloride of sodium were added. No taste was communicated thereby to the water. It was then placed in another leaden jar, and examined as before, but no lead was detected.

To a further portion five grains of chloride of sodium and ten and a half grains of phosphate of soda were added. No lead was detected in the water even after forty days' contact with the metal.

Many other observations were made, the general result of which was, that the purer the water, the more liable it was to become contaminated with lead. Harrison* alludes to the fact that upon examining soft water which has stood in a lead cistern, by holding it up to the light, small dust-like particles will be found suspended in it, which he supposes to be carbonate of lead. I have examined these particles micro-chemically, and am satisfied, from their reactions, that they do consist of carbonate of lead.

Organic matters are frequently present in water, and give it qualities which render it deleterious. They may be either gaseous or morphological, as portions of decomposing vegetable or animal remains, infusoria, algæ, fungi, etc. Water in which such matters are found readily becomes putrescent, and is most noxious to the health of those who use it as a drink, producing diarrhœa and fever.

Water which is stagnant is especially loaded with such impurities, and is therefore peculiarly unfit for drinking purposes. When examined microscopically, abundant evidence of its unsuitableness will be found. We have already alluded to the fact that the water of marshes, when drank, gives rise to malarious fevers. This can only be through the organic matters present in them.

Rivers from which towns are supplied with water are

* Some Observations on the Contamination of Water by the Poison of Lead, etc. London, 1852, p. 30.

often contaminated by the influx of the noxious contents of sewers. It is on this account that the water of the Thames is so impure. During the prevalence of the cholera in London, in 1854, the water supplied to the city was examined microscopically by Dr. A. H. Hassall,* who states "that there is no water supplied to the metropolis that does not contain dead and living organic matter, both animal and vegetable." It was found that some of the water furnished was more free from such substances than others, and that those districts supplied with the better quality of water had fewer deaths from cholera than those to which the more impure water was distributed.

Dr. Ackland† states that in 1832 the parish of St. Clements suffered greatly from cholera, and that at that time the water supply was derived from a stream into which sewers emptied; whereas, in 1849 and 1854, when the water was obtained from another and purer stream, the mortality from this disease was small. Another instance which he mentions is still more to the point. The city jail and the county jail stand close to each other. The former had never had any cases of cholera, while the latter was visited each time that the disease prevailed in Oxford. The county jail was supplied with water pumped from a filthy pond within ten feet of one of the drains. Upon obtaining the water from another source the cholera disappeared.

The late Dr. Snow‡ brought forward many facts tending to show that cholera was only communicated by means of drinking water. Without accepting so exclusive a hypothesis, we must admit that there is every probability

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* Sutherland's Report on Epidemic Cholera in the Metropolis in 1854, presented to Parliament in 1855, p. 41.

† Memoir on the Cholera at Oxford in the year 1854. London, 1856, p. 51.

‡ Mode of Communication of Cholera. 2d edition, London, 1855.

that this is one of the chief means by which the disease in question is disseminated.

For the purpose of drinking, then, it is of essential importance that water should be free from any very large amount of mineral substances or organic matters. It should be inodorous, clear, and without any well-defined taste. It is scarcely possible, even were it desirable, to obtain water entirely free from inorganic and organic matters. As has been said, in passing through the strata of the earth's surface, or over the beds of rivers, water dissolves all soluble substances with which it comes in contact. Vegetable and animal organisms are constantly found in it. It may be said with truth that water in which infusoria do not exist is not the best fitted for ingestion; for so universally do they make this fluid their habitat, that their absence is *prima facie* evidence that something is wrong with the water in which they are not found. Decaying animal and vegetable remains are always injurious, and water containing them in appreciable quantity should be absolutely avoided.

In the use of water there are certain principles by which we should be guided. It should not be drank, especially when very cold, when the body has been overheated and has commenced to cool. Immediate death has frequently ensued from the neglect of this rule. The habitual use of ice-cold water, so prevalent among all classes in this country, is calculated to injure the tone of the stomach, and to produce diphtheria. It is also often the cause of diarrhœa, but when temperately used, tends to keep the bowels open. I know a gentleman who can at any time produce in himself griping pains and loose discharges by drinking a tumbler of ice-water. Severe colicky pains are often the consequence of its use.

I do not think the drinking of large quantities of water at meals is at all calculated to lessen the digestive powers by diluting the gastric juice. Very soon after being swal-

lowed, water is absorbed directly into the circulation, and the gastric juice is constantly being secreted while there is food in the stomach. For many years I have been in the habit of drinking several tumblers of water at each meal, without in the least interfering with digestion, and I am acquainted with other persons who have followed a similar practice without injurious results. Experiment, however, places the matter beyond any reasonable doubt.

I fed a dog moderately, and then administered to it a pint of water. Fifteen minutes afterward the animal was killed by division of the medulla. On opening the stomach, having previously tied it at its cardiac and pyloric openings, nearly all the water was found to have been absorbed. The food was as far advanced in the process of digestion as it should have been for the period during which it had been in the stomach. There was the ordinary quantity of gastric juice present.

Water, even in large quantities, so far from being injurious when taken during or immediately after a meal, is, on the contrary, serviceable through its action in softening the food, and thereby rendering it more susceptible to the solvent influence of the gastric juice. Through its own solvent powers it dissolves certain of the principles of the food, which are more rapidly made available for the formation of tissue, by reason of the fact that they are absorbed with the water directly into the blood.

Water drank before going to bed is also salutary, in washing out any remains of food which may still continue in the stomach.

Cold water taken upon an empty stomach is far more injurious than when drank after a full meal has been ingested. Violent cramps, and vomiting and purging have been produced by ice-water, drank when the stomach was empty. I have witnessed several cases of this kind among soldiers. Moderately cold water is that, however, which is

most grateful to the stomach, and is most efficacious in quenching thirst.

Tepid water is insipid and nauseous, though occasionally, in cases of dyspepsia, more agreeable than very cold water.

Hot water, when drank, excites the circulation, and communicates a glow to the skin. A draught of it taken at night by those who are subject to coldness of the extremities, produces very agreeable results. If taken habitually, and in large quantities, it weakens the tone of the stomach and intestines.

More water is drank in summer than in winter, in consequence of the increased loss which the system sustains through the skin during warm weather.

The sensation of thirst is exceedingly painful, and is much less endurable than hunger. The extreme dryness and clamminess of the fauces and œsophagus, the parched and swollen tongue, the fever and delirium which are some of the accompaniments of extreme thirst, make a more painful collection of symptoms than that which is attendant on hunger. Though the sensation of thirst is experienced at the upper extremity of the alimentary canal, the want exists in the system at large. This is proven by the fact that thirst may be assuaged by bathing, sufficient water entering the blood through the pores of the skin to accomplish this act. It may also be relieved by injecting water into the stomach. The strongest evidence, however, that thirst does not consist in dryness of the fauces is afforded by the fact cited by Bernard, and which I have several times verified, that if a fistulous opening exist in the stomach of a dog, so situated that the water drank will escape by it as fast as imbibed, no matter how much the animal drinks, its thirst is not abolished.

From the hardships to which they are often subjected, soldiers are very liable to suffer from thirst, and frequently from disordered sensations simulating thirst, but which in

reality are not evidences of a want of water in the organism. This state of the fauces is induced by the pernicious habit of drinking at every stream of water that is met with, and filling the canteen for continual use along the road. The consequence is, that the throat acquires the habit of being kept constantly wet, and when the customary liquid is withheld for a few hours, very great distress, scarcely to be distinguished from the first symptoms of thirst, is produced. By refusing to yield to these disordered sensations, the bad habit may be in a little time corrected; but the men should be instructed by their officers to avoid, as much as possible, in the first instance, giving themselves up to a habit which is productive of great distress, and which, when gratified, is indulged without any permanent relief of the disagreeable feeling about the mouth and fauces being obtained.

Thirst, when real, cannot be relieved by anything as well as by water. Acidulated drinks allay it, but not so effectually as simple water. Wine and other alcoholic liquors are worse. Perhaps the best substitute is cold tea. It certainly affords more relief than even water for the dryness of the fauces and clamminess of the mouth, above referred to as simulating thirst. Any solid substance, as a bullet or a coin, kept in the mouth gives relief to these sensations.

Snow increases the sensation of thirst, ice lessens it. Why this difference should exist in these two analogous substances is not very apparent, but the fact is beyond question. In fever, the relief afforded to the system by the ingestion of ice is well marked. The heat of the skin is reduced, and the nervous system quieted.

Examination of Drinking Water.—By ascertaining the specific gravity of the water to be tested, a rough idea of the *quantity of solids* contained in it can be obtained.

Kirwan* gives the following formula for this purpose, which he states will generally indicate the proportion within one or two per cent.

Deduct from the specific gravity of the water the number 1000, and multiply the difference by 1·4, the product will represent the quantity of solid contents. It gives the weight of the salts in their most desiccated state, and consequently freed from their water of crystallization. The weight of fixed air must be also included.

Thus, if the water under examination possess a specific gravity of 1015, the 1000 subtracted from this sum leaves 15, which, multiplied by 1·4, gives 21, the number of parts of solid matter in 1000 parts of the water. A better plan is to evaporate to dryness a certain amount of water, and to weigh the solid residue.

Sulphuric acid is most readily detected by solution of chloride of barium, by the action of which a heavy white precipitate of sulphate of baryta is produced.

Chlorhydric acid is indicated by solution of nitrate of silver, by which a flaky precipitate of chloride of silver, soluble in liquor ammoniæ, is thrown down.

Sulphuretted hydrogen, if present, forms, with solution of acetate of lead, a brown precipitate of sulphuret of lead. In water containing *lead*, sulphuretted hydrogen, when passed through it, gives a like precipitate.

Lime gives, with oxalate of ammonia, a white precipitate of oxalate of lime.

Magnesia is indicated by liquor ammoniæ, which separates it as a light flaky precipitate.

Iron forms, with tincture of galls, a black precipitate of tannate of iron; with ferrocyanide of potassium, a dark-blue precipitate of ferrocyanide of iron is formed.

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* A Treatise on the Composition and Medical Properties of the Mineral Waters of Buxton, etc. etc. By Sir Charles Scudamore, M.D., F.R.S. London, 1833, p. 1.

It is seen therefore that, with a very few reagents, an examination can be made which will afford valuable information relative to the character of the water tested. An approximate idea of the quantity of each constituent present may be formed in this way, which will, in general, be all that is needed. When accurate results are desired, a balance must be employed.

It is not intended to enter at length into the questions connected with the chemical analysis of water. All that is desired is to point out a few practical tests which can be applied at a few minutes' notice, and with no other apparatus than a couple of test tubes.

Organic Constituents.—The organic constituents of water when not in solution are readily detected by means of the microscope. The living structures will be found to consist of confervoid algæ (confervaceæ, desmidiaceæ, diatomaceæ, etc.) and infusoria. Nearly all water contains a certain proportion of these organisms, and stagnant water abounds with them. The higher forms of infusoria do not, however, frequent water which contains a large amount of decomposing vegetable or animal substances.

When water is found by microscopical examination to be overstocked with infusorial or algoid structures, it is not that which is best fitted for drinking purposes; but before arriving at a definite opinion, certain precautions are necessary. A great deal of exaggeration has been indulged in by the writers of popular works on microscopy relative to these organisms. In themselves they are of little consequence. It has never been shown that any of the infusoria are poisonous. They simply afford evidence that the water in which they are found contains organic matter. When they are in great abundance, it is a safe presumption that there is also a large quantity of food for them likewise present, and this food consists of vegetable or animal matter. If such water is kept for a few hours in a vessel ex-

posed to the air, it will become putrescent. Such water will not support the higher forms of infusoria.

When pure distilled water is exposed to the air for a day or two, and then examined microscopically, it will be found to contain algæ and infusoria. Rain water is especially selected by these structures. The presence of a green scum, consisting of confervoid growths, is no indication that the water is impure. Many of them are only found in clear and pure water, which they tend to keep sweet by their purifying action. The zygnemaceæ and the diatomaceæ are objectionable, on account of the readiness with which they undergo fetid decomposition when disturbed and injured.*

Some of the vegetable and animal organisms found in water impart to it uniform characteristic colors. Thus, a green hue is given to it by certain species of protococcus polycystis, etc., and a red tinge by other forms of protococcus astasia, etc. The red color frequently found in the snow of the polar regions and of great altitudes, is due to the presence of a confervoid growth—*Protococcus nivalis*.

In examining water microscopically, with the view of ascertaining its fitness for drinking, a drop should be taken up with the pipette, placed on a glass slide, and covered with a piece of thin glass. It is then ready for inspection. The examination of the sediment affords no reliable indications relative to the proportion of living organisms present in the water from which it has been deposited.

The *spores of fungi* are also often found in water, and can be detected by microscopical examination. It is rare that any but marsh water contains them. As we have already seen, it is probable their presence is a source of disease to those drinking the water in which they are found.

Decaying vegetable and animal remains often require no other means than the unaided senses for their detection.

* See Micrographic Dictionary, article *Water*, p. 684.

When minutely divided, the microscope will at once determine their character.

Organic matters, when in solution, can be most satisfactorily discovered by means of solution of permanganate of potassa. This salt gives a bright-red color to the distilled water in which it is dissolved, which hue is entirely removed on subjecting it to the action of organic matter. We have thus a valuable means of detecting impurities which would otherwise escape observation. The method of proceeding is very simple. A drop of saturated solution of permanganate of potassa, or of Condy's disinfectant fluid, (which consists of a solution of alkaline permanganates,) added to a half pint of distilled water, gives to it a beautiful pink color, which will remain permanent for a long time; but if the same quantity be added to any ordinary drinking water, the permanganate is decomposed by the organic matter present, and the characteristic color is destroyed as soon as found. If there be much organic matter present, more of the solution will be required to produce any color at all; and, by the quantity used to cause the formation of a permanent pink tinge, we draw our conclusions relative to the purity of the water examined. The presence of minute particles of organic matter is also readily indicated by this reagent.

I prepared a standard solution of permanganate of potassa, one drop of which gave a permanent pink color to ten fluid ounces of distilled water. Into this mixture I placed a single blade of grass, with the effect of instantly destroying the color. In another experiment, two drops of an infusion of hay were sufficient to decolorize the solution. It required four drops of the standard solution to give a fixed color to ten ounces of the water introduced into the City of Washington, eighteen to produce the same result in ten ounces of water collected from a marsh in the rear of the city, and twenty-seven in the water of the canal which flows through the town.

Organic matters may also be detected by sulphuric acid, which gives a dark-brown or black color to water containing any considerable amount of such substances. It should be added drop by drop to the water under examination.

MINERAL WATERS.—The subject of mineral waters is so extensive that it is impossible to consider it with anything like completeness in a general treatise. This is the less to be regretted for the reason that there are several excellent works which treat of the virtues of particular springs and of mineral waters in general.* Almost every variety of mineral water is found within the limits of the United States, and these, with others, are manufactured by Mr. Hanbury Smith, of New York, with great success, leaving scarcely anything to be desired in this particular.

The action of mineral waters on the organism of course depends upon the character of the substances which enter into their composition. Those containing iron are useful in chlorosis and other affections in which chalybeates are indicated. Those in which alkaline carbonates predominate are of service in gout, rheumatism, and gravel. Those in which iodine or its combinations exist may be advantageously drank by individuals of scrofulous diathesis, with goitre, syphilis, etc.

It would be well if arrangements were made for giving the advantages of mineral waters to the sick of the army, as is done in France. In addition to the benefits to be derived from the waters of many springs at our disposal, there can be no doubt that the associations connected with such places would also prove in the highest degree beneficial in a large class of cases of invalids who are not in a condition to join their regiments, and yet scarcely fit subjects for discharge.

* The most complete work on the baths of the United States and Canada is the treatise of Dr. John Bell, of Philadelphia. There are also several other works on particular springs by different authors.

In regard to the examination of mineral waters, it is scarcely necessary that the subject should be considered here. All the principal springs of this country and of Europe have been so thoroughly studied, and their waters analyzed, that it would be a work of supererogation to go over the ground again.

BATHING WATERS.—For purposes of cleanliness, the requisites in water for bathing do not differ from those necessary in a good drinking water. For special hygienic objects very great differences in waters exist. The most universally used water in these relations is that of the ocean, and its efficacy is not to be doubted in a number of diseases which affect mankind, and as a restorator of mental and physical vigor after long-continued labor of body and mind.

Physiologically the action of sea-bathing has, with the exception of the excellent observations made by Beneke,* been very little studied. This physiologist found one of the most important results of sea-bathing to be an increase in the metamorphosis of tissue, and, as a consequence, that more food was required than under ordinary circumstances.

Undoubtedly, however, much of the beneficial effect of sea-bathing is to be ascribed to the sea air, and to the other associations, mental, physical, and social, which belong to the various watering-places on the sea-shore.

M. Lévy† has detailed the results produced upon the men at Dieppe who assist in the bathing, and who are, consequently, immersed in the sea, as high as the waist or knees, for many hours each day, while the season lasts. According to this observer, the effects of the immersion depend upon the height to which the water reaches. If it extends as high as the breast, it gives rise, at the com-

* Ueber die Wirkung des Nordsee-Bades, etc. Göttingen, 1855.

† Annales d'Hygiène, 1861, tome xv. p. 241.

mencement of the season, to dyspnœa and anxiety, which sometimes become so excessive as to oblige the guide to leave the water. As the season advances, these sensations become less strongly marked, and finally disappear.

When the extremities only are immersed, an intense sensation of cold is experienced. If the water is entered fasting, the cold felt is more severe, and the reaction is less decided, than if a slight repast is taken previously.

The excretion of urine is very much increased in these men, and at night they perspire profusely.

Though sea-bathing is calculated to be of benefit in many diseased or disordered conditions of the system, it is certainly productive of very injurious results in others. In phthisis, for instance, it is far from being beneficial, and cases of rheumatism are generally rendered worse by its action. In women, however, who require a tonic course of treatment on account of leucorrhœa, menorrhagia, amenorrhœa, prolapsus uteri, chlorosis, etc., and in children suffering from cholera infantum, tabes mesenterica, strumous swellings of the glands and joints, etc., sea-bathing and sea air are almost always serviceable.

In the army it could not fail to be useful in the cases of those who are recovering from chronic diarrhœa, typhoid or typhus fever, or from the debility consequent on wounds. Its good effects have been well marked at Point Lookout General Hospital, which, though not situated on the seashore, possesses the advantages of sea air and the salt-water bathing of Chesapeake Bay.

Mineral baths are useful in many disorders. Those containing sulphur and iodine are beneficial in syphilitic and mercurial affections, and in rheumatism, gout, and scrofulous diseases.

In regard to the hygiene of ordinary bathing, few subjects of sanitary science are of greater importance. In the first place, by removing the accumulated excretions from

the surface of the skin, bathing opens the pores, and allows of the free transpiration of those matters which it is the office of the skin to remove from the system. Obstruction to the action of this emunctory causes very great disturbance in the working of the several organs of the body, and disease is, in consequence, produced. Baths are properly divided into cold, warm, and hot. Each of these varieties produces a distinct and characteristic effect upon the organism; and in addition there is the vapor bath, the action of which is analogous to, though not identical with, the hot bath.

COLD BATHS.—The temperature of the cold bath ranges between 33° and 70° Fahrenheit, according to the season of the year; for a bath that would feel quite cold in summer at 70°, would be moderately so in winter. A low temperature is better borne, and the reaction is stronger, if bodily exercise has been taken previously.

A cold bath should not be taken either immediately before or after a meal, for it is liable to cause disordered digestion by the disturbance which it creates in the distribution of blood to the stomach and intestines. The best period for cold bathing is either in the morning, about an hour before breakfast, or at night before going to bed. In the first case, the system is invigorated for the day, the body has endured as great a reduction of temperature as it is probable it will encounter, and has reacted from it, and hence the liability to take cold is lessened. This period is best for those who have vigorous constitutions, and who consequently can get up a healthy reaction without the aid of extraneous appliances. The night is better for those who are not gifted with the fullest physical powers. Immediately on leaving the bath, the individual should go to bed, when reaction will progress by the aid of the covering, and a sound and refreshing sleep will generally follow.

A very safe guide as to the hygienic effect of cold bath-

ing is afforded by the subsequent phenomena. The immediate effect of the cold bath is to depress the vital powers. The heart beats with less force and frequency; the nervous system receives a shock, varying in strength according to the higher or lower temperature of the water; the blood is driven to the internal structures of the body, and the surface is chilled. But if the organism is possessed of a due degree of power, on leaving the bath these conditions commence to change. The heart recovers its activity; the nervous system regains its tone; the blood begins to return to the surface, and a general glow pervades the system. This condition is called the "reaction." If, however, the vital powers are weak, this change takes place but slowly, and even after several hours the normal balance is not restored. The surface of the body continues cold—the extremities especially so; the countenance is shrunken and bluish; the torpor of the nervous system remains, and there is consequently an indisposition to exertion of any kind, and the circulation preserves its feebleness and languor.

When cold baths are followed by the reaction above described, it is certain that their influence upon the system is good, but when a condition such as that last represented ensues, it may be asserted with equal positiveness that they are injurious. They should therefore be at once discontinued, and the tepid bath substituted for them.

Old persons and infants do not bear cold baths well. In early and old age the system requires all the heat it can obtain. In organic diseases, and generally in those of a chronic character, from the effects of which the system has become much reduced, cold baths should not be employed. Much injury is therefore done by the indiscriminate employment of cold baths at the water-cures, as they are called.

There are various ways of administering the cold bath.

Certain parts of the body only may be immersed, or the whole body may be covered, as in the plunge bath, or the water allowed to fall upon it from a height, as in the shower bath. Of all the various forms of cold bathing, this last gives the greatest shock to the system. It should never be employed except by those of the strongest constitutions. The practice which prevails in penitentiaries, and from which the army is not altogether free, of administering shower baths indiscriminately, without regard to the constitution or condition of the individual, to refractory prisoners and soldiers, cannot be too severely reprehended as both cruel and dangerous.

Rubbing the body with coarse towels after bathing is beneficial, as tending to produce the necessary degree of reaction. Active physical exercise also aids in accomplishing the same result, as will likewise warm and stimulant drinks.

Affusion of the body is the mildest way of employing cold water as a bath. There are few constitutions so delicate that the use of this means will not prove advantageous. A mild glow is produced after the very slight depression of temperature which the body undergoes. For very debilitated persons the temperature should not be too low; 60° will be well borne in the great majority of cases. The best period of the day for the habitual use of the shower bath is immediately after rising in the morning.

Cold affusion is useful in the treatment of several diseases, especially those belonging to the exanthemata. The great heat of the skin is lessened, and the force and frequency of the pulse reduced.

The *cold douche* differs from the shower bath in this, that in the former the stream is conducted to the part in a compact column, while in the latter it is broken into smaller streams. The *douche* is a powerful means of reducing the activity of the vital processes, and in mania and sthenic

delirium, as they were formerly witnessed, was very generally employed. It is occasionally useful as a therapeutic measure in sprains, rheumatism, and other local affections, but has few if any hygienic advantages over less powerful means at our command. Cold water admits of many other applications in medicine and surgery than those to which, merely as examples, we have referred.

WARM BATHS.—The temperature of the warm bath ranges from 85° to 95° Fahrenheit. As a cleansing agent, warm is far more efficacious than cold water, on account of its increased solvent properties, and the greater facility with which it removes the oily particles which have accumulated on the skin.

The warm bath is better adapted to individuals of weak constitution, and to old or very young persons, than the cold bath. Its stimulating effects are moderate, but at the same time decided. The blood is attracted to the surface, the vessels are dilated, the nervous system participates in the excitement, and the action of the heart is accelerated. These phenomena continue for a short time after leaving the bath, but are apt to be followed by a corresponding degree of depression, unless the effect is kept up by the natural action of bodily exercise.

The best period of the day for taking a warm bath is about an hour previous to dinner, so that the circulation will have time to resume its ordinary course before this meal is eaten. If used immediately before or after a full meal, the blood is directed in a great measure from the abdominal viscera, and the secretions necessary for digestion are interfered with.

Warm water is applied locally to different parts of the body as a derivative, but its effects are not so great in this respect as those which follow the employment of hot water.

HOT BATHS.—The temperature of a hot bath is from 95° to 110° Fahrenheit, the latter point being about as high a

degree of heat applied through the medium of water as the whole body ordinarily can endure; though to particular parts of the body a considerably greater temperature can be applied without suffering being produced. Habit here comes again into operation, as, by gradually increasing the temperature, a much higher range can be reached.

The effects of hot water at 110° are very decidedly stimulating, and, in a hygienic view, its uses are very limited. Therapeutically it is beneficial in rheumatism, gout, and affections of the kidneys. It also admits of partial application for the relief of hemorrhoids, amenorrhœa, convulsions, paralysis, etc.

There are a number of natural warm and hot springs in the United States, the waters of which being in several instances possessed of medicinal virtues, are much frequented by invalids, and might be advantageously made use of in army practice in the treatment of cases of chronic rheumatism and constitutional syphilis.

The water best adapted for ordinary bathing, in which only the cleansing effects, or those due to the influence of cold, heat, and moisture are desired, is that which is free from much mineral or organic matters. If the former be present in large quantity, the soap is not readily dissolved, and hence the influence of this alkali is lost; if the latter, the body is subjected to contamination, from which very injurious consequences may ensue.

It is greatly to be regretted that so little attention is paid in the army to the requirements of health in the matter of frequent and systematic bathing. In the general and post hospitals this subject receives its proper consideration. Bathing tubs are supplied, and the means afforded of obtaining sufficient hot and cold water. No patient whose condition does not absolutely forbid it is received without his being well bathed in warm water; but in the barracks the means are not provided, and, in consequence, the men

are obliged to adopt such make-shifts as they can, or go without any but the most incomplete ablutions. It is to be hoped that greater attention will be paid to this matter by those who have the immediate charge of the men, and that in time bath-houses will be built at all permanent posts and encampments. Attention to this point could not fail to add not only to the comfort but the health and consequent efficiency of the forces.

In the British service this matter has received the full consideration of the authorities, and ablution rooms and bathing accommodations are provided for all barracks. Previous to the appointment of a special commission by the British government to examine into the sanitary condition of the barracks and hospitals of the United Kingdom, there was hardly a barrack provided with bathing facilities.* The commission recommended that immediate provision should be made for remedying this defect.

An arrangement similar to that described by M. Dunal† as existing in the barracks at Marseilles, might be advantageously adapted to nearly all our barracks.

A building about thirteen feet square was built, and divided by a partition into two parts. The first was used as an undressing room; the other was supplied with water conveyed through a pipe from the city main. The pipe was about an inch and a half in diameter, and was terminated by another tube pierced throughout its length (about three feet) by small holes. The men entered this chamber from the one in which they had undressed, and passed in rotation under the shower, three or four at a time. Each man was furnished with a small piece of soap, and three

* General Report of the Commission appointed for Improving the Sanitary Condition of Barracks and Hospitals. Presented to both Houses of Parliament by command of Her Majesty. London, 1861, p. 47.

† Notice sur les Affusions Froides. Recueil de Mémoires, etc., tome l., 1861, p. 380.

minutes sufficed for the ablutions of each party. Three hundred and fifty soldiers, under charge of their corporals and the sergeant of the week, were thus washed every day from twelve to four o'clock, and without disorder of any kind. The effect upon the health of the men was well marked. Skin eruptions were prevented, and gastric disturbances and diarrhœa were rendered less frequent. By keeping the body clean, the air of the barrack rooms was made less offensive, and thus a great source of disease deprived of much of its power.

In camps and garrisons the men should be regularly marched to the river during the summer season, under charge of an officer, and required to bathe. I am satisfied that if this were made a part of their duty, there would be a very marked diminution of sickness, and a very decided increase in the comfort of all concerned. So far from the men disliking bathing, when the subject is brought to their attention, and the conveniences provided, they like it, according to my experience and that of other officers with whom I have consulted. M. Dunal expressly states that the men took great pleasure in their shower baths at Marseilles.

Though the subject of bathing admits of much further consideration in its hygienic relations, we have already extended its discussion as far as the limits of this volume will permit.

WASHING WATER.—Water for the purposes of washing should be of the character known as soft. Hard waters owe their peculiar properties to the presence of calcareous and magnesian salts, and are unfit for washing till these substances have been neutralized. Soap will not cause a froth in such waters; if added to them in small quantity it is not dissolved, but forms a flaky precipitate with the salts above mentioned. If soap continues to be added to hard water, it finally separates all the objectionable constituents

from it, and the water is thus rendered capable of dissolving any soap which may subsequently be placed in it.

Through soap we therefore have a ready test of the adaptability of water for cleansing purposes. MM. Boutron and Felix Brudet* are the originators of this means, which is both of easy application and affords very accurate results.

A solution of soap is made in alcohol, and its strength determined by means of a test solution of chloride of calcium. From the amount of soap destroyed by a given quantity of the water examined, an exact idea of the value of this water for washing is at once obtained.

For ordinary purposes, when absolute exactitude is not required, it is sufficient to form a test solution of soap, of any convenient strength, and to add it to the water under examination as long as a precipitate is thrown down. The mottled Castile soap is the best to use. By this simple method very good comparative results are obtained. That water which requires most of the solution to be added to it before the precipitate ceases to be formed, is least adapted for washing purposes.

Soap, as will readily be inferred, is also an excellent test of the quality of water as a drink, and can be so easily employed that its use in examinations of the kind should never be omitted.

THE MEANS OF PURIFYING WATER.—The methods in use for rendering water, which is impure, fit for the uses of man, may be considered under two heads: First, the physical separation of the injurious substances; and second, their destruction or removal by chemical agents.

The separation of impurities from water by mechanical means is accomplished either by filtration, decantation, agitation with atmospheric air, or distillation.

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* Comptes Rendus, March 26th, 1855. Also, Chemist, vol. ii. 1855, p. 478.

Filtration affords a very ready means of removing those matters from water which are insoluble in it. Water filled with earthy substances, but otherwise of good quality, may be rendered very fit for drinking by filtering it through sand contained in a pyramidal box. The apex of the box is sawed off and loosely closed with a little hay or straw. It is then inverted over a barrel and filled with sand. The water to be filtered is poured on the sand and it passes through to the vessel beneath perfectly freed of its earthy particles. Many substances held in solution in water can be thus removed from it. Even the saline constituents of sea water are separated by a filtration through a stratum of sand thirty feet thick.

This property of sand to act as a filter is frequently made use of in hospitals and other large establishments, where great quantities of pure water are required. Several years since M. H. Fonvielle,* by causing the water supplied to the Hôtel-Dieu to pass, under a pressure of forty-one feet, through a filter of sand, succeeded in furnishing that hospital with an abundance of pure water.

Many other methods of making use of sand, wholly or in part, have been devised, and are of easy application in camps. That of Dr. Lind† is very simple. A large cask is procured, and the head knocked out of one end, another of less transverse diameter, but longer, having both heads removed, is placed within the first. The inner cask is to be about half filled with clean sand, and the space between the casks is to be one-third filled with sand. A cock is to be placed in the side of the outer cask at a point about fifteen inches above the level of the sand in the interval. Upon pouring the impure water into the inner cask it

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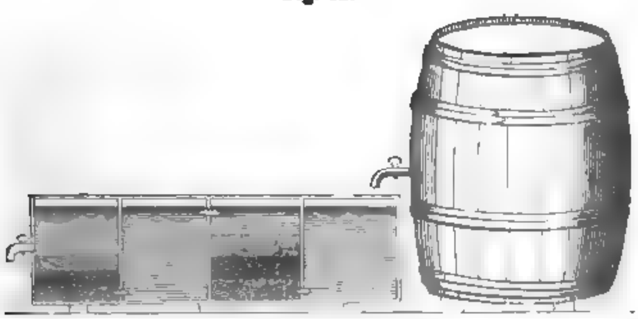
* Mémoir sur l'Hygiène et la Statistique des Hôpitaux de Paris, par M. A. Bouchardat. Ann. d'Hygiène, 1837, tome xviii. p. 319.

† On the Health of Seamen.

filters through the sand and flows out of the cock in the side of the outer cask. Boxes will, of course, answer every purpose if barrels cannot be procured. By the use of this means any camp can always be supplied with water free at least from particles of mineral or organic matter.

The apparatus described by the late Dr. Cutbush,* of the United States Navy, offers some advantages over that last mentioned. A water-tight trough is constructed, and divided into four compartments. The first of these is half filled with gravel, powdered charcoal, and clean sand, in alternate layers, the second is left empty, the third is two-thirds filled with the substances mentioned, and the fourth left empty. The partitions between the first and second, and third and fourth compartments, are pierced near the bottom by a number of holes, half an inch in diameter, that between the second and third by similar holes near

Fig. 12.



the top of the trough, and the end of the trough is furnished with a cock inserted a few inches above the level of the sand. At the other end a barrel is placed, also supplied with a cock. The whole arrangement is shown in Fig. 12.

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* Observations on the Means of Preserving the Health of Soldiers and Sailors, etc. Philadelphia, 1808, p. 115.

When water is to be filtered it is poured into the barrel, it passes thence into the fourth compartment, thence through the holes near the bottom into the third. Here it rises through the gravel, charcoal, and sand, depositing the greater part of its impurities, and flows through the holes at the top of the partition into the second receptacle. Thence it passes through the holes near the bottom and enters the first compartment, when, passing through the strata contained therein, it flows out through the cock in the end of the trough. From experience, I can speak of this apparatus as being a very excellent one, and as acting with sufficient rapidity to supply all the culinary and drinking wants of a regiment of men.

In the next place we come to the consideration of the charcoal filters, which, on many accounts, are to be preferred to any other. Charcoal possesses the great advantage of not only mechanically removing those impurities which are suspended in the water, but it also acts, especially animal charcoal, in rendering water which is putrescent, or otherwise impure from the solution in it of animal or vegetable substances, perfectly fresh and sweet.

Several years since Gaultier de Claubry,* at the request of a filtering company of Paris using Fonvielle's method, reported on the subject of charcoal as a filter, and came to the conclusion that the advantages derived from it were not such as to compensate for the increased expense and inconvenience.

Although admitting the disinfecting qualities of the charcoal, he decided that water purified by it regained, after a certain time, its first properties, through the decomposition of the organic matters still held in solution; and that although animal charcoal was far preferable

* Rapport sur l'Emploi du Carbon pour le Filtrage en grand, des Eaux Destinées aux Usages domestiques. Ann. d'Hygiène, 1841, tome xxvi. p. 381.

as a depurator to vegetable charcoal, the difference in cost was not in relation with their disinfecting qualities. He also determined that water, in passing through charcoal, parted with a portion of the atmospheric air dissolved in it, amounting to as much as one twenty-sixth part.

As to water, which has been thoroughly depurated by charcoal, regaining its impurities after the lapse of any length of time, provided proper means be taken to keep organic matters from contact with it, my own experience is altogether against the correctness of such a conclusion. I have kept water, which had originally been of a very bad quality—loaded with vegetable and mineral matters—for over a year after purification by filtration through charcoal, without its again becoming in the least impure. Neither have I been able, after a number of experiments, to ascertain that any of the air dissolved in water is absorbed by the charcoal used in filtration, except a small portion contained in the water first passed through the filter.

Common vegetable charcoal, either used with gravel and sand, as in the apparatus mentioned by Dr. Cutbush, or alone, can generally be employed in camps and garrisons without inconvenience, and with the most satisfactory results. Not only are the mineral and organic particles removed, but a great portion of the impurities held in solution are separated.

Various forms of carbon filters are manufactured, and answer exceedingly well. One of the best that I have seen is Fowler's, a large number of which were supplied last summer to the army hospitals situated in places where good water was not abundant. Fowler's carbon filter consists of a hollow, porous sphere of finely powdered animal charcoal, which has been made to retain its form by being subjected to powerful pressure, contained in a cylindrical tin box, in the bottom and circumference of which are

several small holes. A tube of India-rubber communicates with the cavity in the sphere. (Fig. 13.)

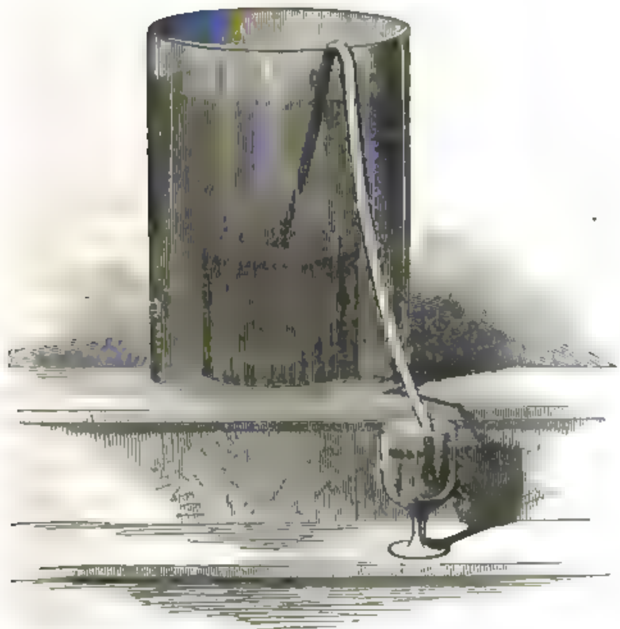
Fig. 13.

To use this filter, it is placed in the water to be purified, and exhaustion made with the mouth applied to the free end of the tube. Care must be taken that the end of the tube hangs lower than the position of the filter, otherwise the water will not continue to flow. If this point is attended to, on removing the mouth the water will issue from the tube purified of any particles of matter it may have contained. In this way water may be conveyed from one barrel into another, and in the transit deprived of its noxious ingredients. In Fig. 14 the mode of using this filter is shown.

A very excellent and convenient filter is constructed of a cylinder of porous bisque, communicating at one end with a piece of India-rubber tubing. On putting the cylinder in water and exhausting with the mouth at the other end, a limpid stream is obtained, which will continue to run as a siphon if the proper conditions are complied with. It is so small that it may readily be carried in the pocket, weighing as it does scarcely an ounce and a half.

There are many other kinds of filters, but none, so far as I know, superior to those just described.

Fig. 14.



Decantation.—Water which contains heavy particles of mineral substances may be, to a great extent, freed of them by allowing it to remain in a vessel undisturbed for several hours, so as to allow the impurities to subside. It may then be drawn off by a siphon into another vessel, or used without this operation. It will be found, however, that although the water is rendered much clearer by allowing it to stand for some time, it will not become perfectly clear, owing to the fact that a great portion of the matter is of about the same specific gravity as the water, and consequently remains in suspension.

Agitation with atmospheric air is an excellent method of freeing water of impurities which are dissolved in it. This

may be done either by pouring it from one barrel into another through a colander, by blowing into it with a pair of bellows, or by the use of the apparatus devised by Mr. Osbridge, of the British Navy. This consists of a hand-pump inserted into a cask of water, and by the action of which the water is raised. It is then made to fall through several sheets of tin, perforated like colanders. By this means the water is divided into small particles, and freely exposed to the action of the air. The decomposing matters are thus oxidized, and the water rendered sweet. Water which has been kept at sea for a long time and has become putrescent, may be made perfectly palatable by this process.

Distillation.—By this method water may not only be purified of palpable matters, but also of all impurities held in solution. On a large scale it is conducted by means of a copper still. For small operations retorts are used. All sea-going vessels should be supplied with suitable apparatus for distilling water. Even sailing vessels can be so furnished with but little expense, a head and worm being adapted to the boiler in which the soup is made. Sea water is thus rendered sweet, and by agitation with atmospheric air becomes perfectly fit for drinking purposes. This last operation is very necessary, as water which has been deprived of its air by boiling is very flat and insipid, and does not fulfil all intended purposes in the economy.

As a distilling apparatus, however, nothing at present in use is comparable to that devised by Dr. Normandy, which not only purifies the water, but aerates it at the same time. From a report made by Surgeon B. F. Bache, United States Navy, for an examination of which I am indebted to Dr. Whelan, Chief of the Bureau of Medicine and Surgery of the Navy, it appears that ten thousand grains of the water furnished by this apparatus contains but three grains of solid matter, equivalent to twenty-one

grains to the imperial gallon, or ·003 per cent. The water from the hospital well at the navy yard, New York, which is remarkably pure, contains ·0184 per cent. of solid matter. Dr. Bache further states that "the product was clear, not acid, and apparently thoroughly aerated and free from the flat taste of ordinary distilled fresh water." It would be well if the permanent sea-coast fortifications, which generally are not furnished with the best water, and all sea-going vessels were supplied with this apparatus, which is capable of yielding from three to five thousand gallons daily of fresh aerated water.

CHEMICAL MEANS OF PURIFICATION.—By agents which act chemically on water, impurities which it contains may be neutralized or altogether destroyed. One of the most simple means under this head is boiling, which precipitates some of the mineral constituents that may be present, and destroys all infusoria, spores of fungi, and, to some extent, decomposing vegetable matter. Like water which has been distilled, that which has been boiled requires to be agitated with atmospheric air to be rendered palatable.

Organic matters may also be destroyed by adding *quicklime* to water containing them, but as there are other processes possessing greater advantages, this is not recommended.

Alum, added to water in small quantities, causes mineral particles to settle rapidly to the bottom.

The *permanganate of potassa*, or the solution of permanganates prepared by Mr. Condy, of London, answers admirably well for the purification of water contaminated with organic matter. Thus water, which has been taken from a well situated in proximity to a cess-pool, privy, or other source of impurities, may be deprived of its injurious qualities by the addition to it of a very small proportion of solution of permanganate of potassa or of the fluid mentioned. Half a teaspoonful of a saturated solution will, ordinarily, answer for a gallon of impure water.

Water which is rendered hard by containing carbonate of lime in solution, may be rendered soft and fit for washing purposes by the process of Dr. Clark.* This consists in adding milk of lime to the water, whereby a carbonate of lime is formed with the carbonic acid, which is precipitated along with that held in solution by the excess of carbonic acid.

From what has been said relative to the purification of water, it will be seen that, for the ordinary uses of men in camp or garrison, filtration is more generally applicable and more advantageous than any other means, and that when they can be procured, the carbon filters are to be preferred. When more care is taken to insure a supply of pure water to the troops, it will be found that a great reduction in the rates of sickness and mortality will result.

CHAPTER VIII.

SOIL.

The crust of the earth, so far from being homogeneous, varies very much in its composition according to the causes which have been instrumental in giving it origin. These causes are three—fire, water, and organic decomposition. From the action of the first-named cause, we have basalt, granite, lava, sand, etc.; from the second, limestone, sandstone, alluvial deposits, coral reefs formed by zoophytes of their own skeletons and other matters derived from the sea, etc. It is probable, however, that originally all soils

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* Chemist, vol. iii., 1856, p. 125.

were deposited from water, and that the agency of fire in altering their characteristics was of subsequent action.

The third cause, organic decomposition, is of very great importance in its influence over the hygienic condition of man. Through its action in some places a vast amount of matter is deposited, to form a portion of the crust of the earth, and to contribute to the fertilization of the soil. To this cause coal, (vegetable matter decomposed through the agency of fire,) guano, (the excreta of birds,) and humus, (vegetable matter decomposed under the influence of air, heat, and moisture,) owe their origin.

In a work on hygiene, it is of course out of the question to enter at any length into the consideration of the structure of the earth's surface, or of the various modifying influences which have been brought into action. All these subjects are fully discussed in the several treatises on geology, to which the student is referred for that knowledge in regard to them of which he ought to possess himself.

The various kinds of soils differ in their capacity for heat. Thus M. Schübler,* from his observations, constructed the following table, which shows great variations in this respect:—

Kind of Earth.	Faculty of retaining heat, that of sand being 100.
Calcareous sand	100
Silicious sand	95·6
Gypsum	73·2
Light clay	76·9
Heavy clay	71·1
Argillaceous earth	68·4
Pure clay	66·7
Calcareous matter in fine powder	61·8
Humus	49·0

As Lévy remarks, we see from these results the cause of the great heat retained by sandy soils in summer, after the

* Traité de Hygiène, par M. Lévy, tome i. p. 480.

sun has set. I have frequently noticed the difference between a soil composed of humus and one consisting almost entirely of sand, when I have had occasion to sleep all night on the ground. On the elevated table-lands of New Mexico the nights were always cool, and it was therefore a matter of importance, in *bivouacking*, to select a sandy bed if possible. It is somewhat remarkable that a late writer on hygiene* asserts that sand has "little capacity for caloric."

The power of soils to absorb moisture constitutes one important point in their hygienic relations, some being much more retentive of it than others, and on this account exerting a deleterious influence on human health. Two circumstances conjoin to influence this hygroscopic property—the porosity of the soil, and the proportion of deliquescent salts which enter into its composition.

M. Schübler† has also investigated this subject with accuracy. He found that five hundred centigrammes of earth, of the kinds specified in the accompanying table, spread out over a surface of thirty-six thousand square millimetres, had absorbed as follows:—

Kind of Earth.	In 12 hours.	In 24 hours.	In 48 hours.	In 72 hours.
	Centigr.	*Centigr.*	*Centigr.*	*Centigr.*
Silicious sand	0·0	0·0	0·0	0·0
Calcareous sand	1·0	1·5	1·5	1·5
Gypsum	0·5	0·5	0·5	0·5
Light clay	10·5	13·0	14·0	14·0
Heavy clay	12·5	15·0	17·0	17·5
Argillaceous earth	15·0	18·0	20·0	20·5
Pure clay	18·5	21·0	24·0	24·5
Calcareous matter in fine powder	13·0	15·5	17·5	17·5
Humus	40·0	48·5	55·0	60·0

It is thus perceived that the argillaceous soils and those composed of humus are pre-eminently distinguished for their

* Hygiene, etc., by J. H. Pickford, M.D. London, 1858, p. 250.
† Op. cit., p. 479.

ability to absorb moisture. On this account ground which is in great part composed of these substances does not answer well for camping purposes. Perhaps the worst of all kinds of soil for a camp is that in which sand and humus form the upper stratum, the lower or sub-soil being formed of clay. Rain which falls on such ground, instead of rapidly evaporating, soaks into and through the first stratum, and, passing into the clayey sub-soil, is absorbed, and causes the surface to remain for a long time damp and unhealthy. On the contrary, when the soil is sandy, and the sub-soil composed in great part of gravel, even when the inclination of the surface is but slight, the water which falls passes far into the earth, and exercises no injurious effect. Many camps have been rendered unhealthy solely, so far as could be perceived, through the bad character of the soil in respect to its power of absorbing and retaining moisture.

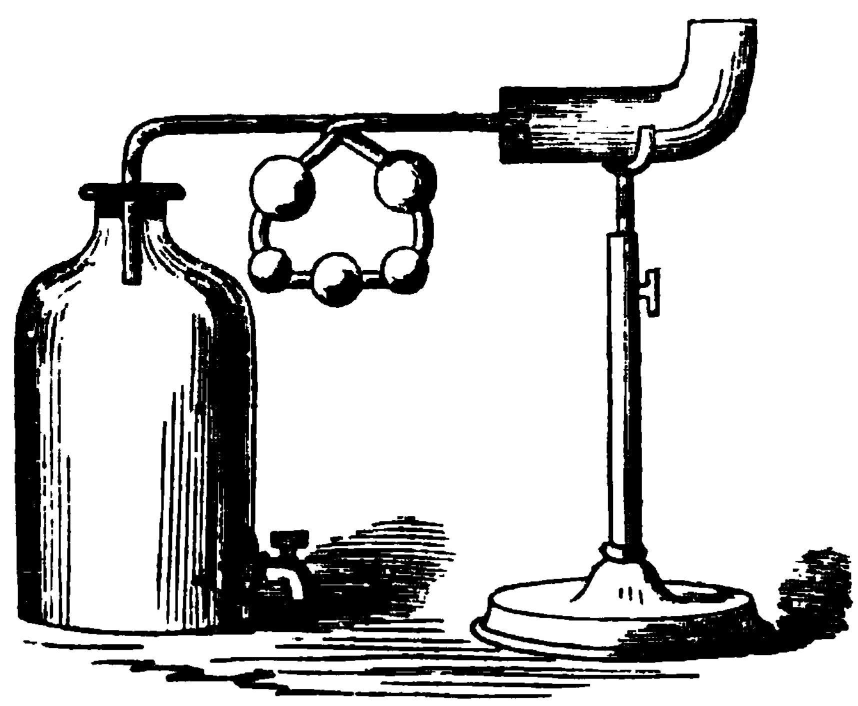
Soil which is covered with large trees or thick undergrowth is not so healthy as that which is exposed to the air, and light and heat of the sun. Evaporation is retarded under such circumstances, and the decomposition of the organic matters present, instead of being speedily effected, is rendered slow and persistent. Such places should never be selected as sites for camps or barracks.

Some soils retain organic matters to a greater extent than others, and hence are bad situations for the location of camps. From some experiments I have recently performed, I have been enabled to arrive at tolerably definite conclusions on this subject.

Thus, in order to ascertain the character of the soil with respect to organic exhalations, a weighed quantity (two hundred and fifty grains) was subjected to the action of a current of air in the apparatus represented in Fig. 15. The potash-bulbs contained a measured quantity (six fluid

drachms) of a solution of permanganate of potassa of definite strength, and the wide tube the soil to be examined. The aspirator was then set in action, and it was observed how many cubic inches of air passing through the soil were required to decolorize the solution of permanganate. The potash-bulbs were then removed, and the large tube immediately attached to the aspirator by one extremity, the other being placed in communication with a large jar containing putrid meat, urine, and vegetables.

Fig. 15.



After a measured quantity of air (fifty cubic inches) had passed through, the tube was separated from its connections, and the potash-bulbs, containing a fresh solution of the permanganate of the same strength as that previously used, were reattached. It was then observed how many cubic inches of the air now passing through the soil were required to decolorize the solution, and thus some indication was afforded of the amount of effluvia absorbed. The following table exhibits the results obtained. The column marked A shows the number of cubic inches of air required to decolorize the permanganate solution before the soil was exposed to the exhalations from the putrefying substances; that marked B, the quantity of air required after the exposure.

Kind of Soil.	A.	B.
Pure sand	73·5	67·5
Dry clay	59	49·5
Sand, clay, and marl	64·5	53
Humus	41	11·5

From this table, it would appear that all the substances experimented with, absorbed to some extent the exhalations from the decomposing substances, and that the humus exceeded all the others in this respect, as, before submitting it to the action of the noxious exhalation, it required forty-one cubic inches of air passing through it to decolorize the solution of permanganate of potassa, while eleven and a half cubic inches sufficed after the exposure. It may be said that the table only shows the relative facility with which the several matters parted with the emanations. It certainly does show this; and, even if this were all, the result, practically, would be of importance; but upon comparing the figures in the two columns obtained with each kind of soil, I think it will be apparent that it also indicates the absorptive power of each substance.

The *configuration of the soil* is also important in its sanitary bearings. Ground which is flat or concave is not well adapted as a location for tents or buildings, on account of the difficulty of draining it properly. On such a surface water accumulates, and is only removed by evaporation or absorption. A moderately rolling surface, or one that is regularly inclined, best fulfils the requirements as to drainage.

The *vegetation of the soil* is not without its influence over the health of those living upon it. Thus, as we have said, forests and other places having a thick vegetable growth upon them are damp and often malarious. Moreover, when the vegetation is luxuriant, decomposition is also active;

so that the air and soil are loaded with the products of decay.

Cultivation is an important element in the condition of the soil as to health. Although the turning up of the ground is in some parts of the country productive of malarious disease, it invariably happens that as cultivation is carried forward, the region becomes more and more healthy. Through this means sections which were at one time noted for their unhealthiness, have been entirely freed from the diseases (generally those of malarious origin) to which they had been liable. I have witnessed many examples of the truth of this, especially in the West, where the correctness of the view expressed is well understood.

CHAPTER IX.

LOCALITY.

THAT some places are more healthy than others, is well known, but the circumstances which conduce to the differences observed in this respect are not always understood. Undoubtedly the character of the atmosphere, of the water, and of the soil are the chief factors in operation; but there are others of which we are ignorant, except through their effects. It is more than probable, however, that if diligent search were made in such cases, the causes of the unhealthiness of certain localities would be found to belong to one or other of the influences above mentioned. Thus, we know that the valleys of mountainous regions are favorable to the production of goitre and cretinism; but why they are so, we do not know. We may suppose the

cause to be the character of the water used, or the want of a due supply of light, or any other of the several influences which have been brought forward; but we have no proof that such is the case.

Mountains, plains, islands, cities, etc. all have their peculiar hygienic features, and are subject to their own special diseases, either through the action of nature or of man. Though we cannot enter at length into the consideration of all the bearings which locality exerts upon hygiene, there are some points of more importance than others, to which attention will be drawn.

Mountains.—The atmosphere of mountainous regions is clear, cold, generally dry, and free, to a great extent, from those impurities which are found in the air of low places. The water is ordinarily free from any organic matters, though occasionally it is highly impregnated with lime and other mineral substances, according to the strata through which it passes to the surface. The soil is usually barren on account of the small amount of organic matter present in it.

So far, therefore, as the atmosphere, water, and soil of mountains are concerned, they would appear to be especially favorable in a sanitary point of view, but in some other respects they are much less healthy than other localities.

Thus in regard to light, the inhabitants of mountain gorges and valleys are very disadvantageously situated. We have seen how important a full supply of light is to man and other organized beings, and we can understand therefore why it so frequently happens that the inhabitants of particular parts of mountain ranges and peaks are stunted and etiolated. In regard to temperature, it is often the case that mountains are subjected to a degree of cold which is unfavorable to the full development and health of the inhabitants.

Goitre and cretinism, to which allusion has been made, are especially diseases of the mountains or of the valleys inclosed by them. By some writers they have been ascribed to the influence of snow-water used as a drink; but this cannot be the cause, for these affections are never seen in the arctic regions, where snow-water is the only beverage used by the inhabitants, and goitre is quite common in mountainous regions within the tropics, where there is an entire absence of snow. Again, the presence of lime and magnesia in the water drank has been supposed to give rise to goitre and cretinism; the absence of iodine from the water, the deficiency of light, the character of the food, and many other agents have been brought forward, but unsustained by any positive proof, so that we are really ignorant of the cause of these diseases, which tend powerfully to the physical and mental degeneration of those who are so unfortunate as to be affected by them. In this country goitre is not very common, and cretinism is altogether unknown. Both are more general in the mountainous regions of Switzerland than anywhere else.

The disease met with among the hunters of the Rocky Mountains, and called by them mountain fever, is scarcely distinguishable from the ordinary typhoid fever of the country. I have twice had opportunities of making *post-mortem* examinations of individuals who had died of this affection, and in both cases found the usual diseased condition of Peyer's glands.

The air of the mountains, together with the change of scenery and other associations, is especially beneficial in those debilitated states of the system resulting from diarrhœa, dysentery, typhoid fever, or intense mental occupation. In chlorosis, and in diseased conditions of the menstrual function, it is not indicated, the sea-shore being preferable.

Very great altitudes are favorable residences for those

who are predisposed to phthisis, for the reason that they conduce to a full development of the chest and respiratory apparatus. Owing to the rarity of the atmosphere at such heights, greater efforts are necessary to obtain the due amount of oxygen. The respirations are deeper, and, as a consequence, the chest becomes more expanded, and the lungs more fully developed. For some time after a residence in places of great altitude, persons are subject to dyspnœa upon the slightest physical exertion, but eventually this passes away, and the respiratory apparatus gains in power and efficiency.

Mountainous localities are not favorable to the generation of malaria, though not entirely free from it. Diarrhœa, dysentery, and other affections of the bowels are uncommon in such regions, but inflammations of the respiratory organs are quite frequent.

Plains.—The sanitary condition of plains is very much influenced by the position as to altitude, the vicinity of mountain ranges, etc. The high table-lands which are found in the neighborhood of the Rocky Mountains, and in their continuation in South America, are noted for the purity and salubrity of their atmosphere and their freedom from endemic causes of disease. On the other hand, plains which are low and surrounded with high lands are proverbially unhealthy. Such plains are frequently alluvial in their origin, and covered with a dense and rank vegetable growth, which adds to their insalubrious character.

Marshes.—After the remarks which have already been made in regard to malaria when the atmosphere was under consideration, there is not much to say relative to marshes. But aside from the fact that ordinarily they are foci of malaria, they are unhealthy on account of the great extent to which vegetable decomposition goes on in them, and the consequent exhalation from them of substances which exert an injurious influence over human health. On this

account, if for no other, camps should not be pitched in their vicinity.

It is a mistake, however, to suppose that all marshes produce malaria. I have known several extensive morasses, in the immediate vicinity of which there were no malarious diseases among the inhabitants.

Localities at the mouths of rivers are, as a rule, more unhealthy than those at their sources. This fact is owing to the deposit of organic matter which undergoes decomposition, or affords a favorable nidus for the growth of fungi, the spores of which may give rise to malarious diseases. Rivers, in passing through extensive regions covered with a luxuriant vegetable growth, as those bordering the Mississippi, the Missouri, the Amazon, the Orinoco, etc., obtain an abundance of matter tending to affect the healthiness of cities located on their banks, especially those at their mouths. Through the sewers and manufactories of large cities, and animal matter of various kinds, other substances injurious to the health of those living on the banks of rivers are derived.

The Sea-shore.—The sea-shore is regarded by many as a favorable residence during the warm season, at least for invalids affected with nearly all diseases. For phthisical patients, and for those with rheumatism, it does not ordinarily prove advantageous. The influence of sea-bathing is often beneficial in such cases; but the constant humidity of the atmosphere, and the liability to sudden changes of temperature from cold winds, neutralize the benefits derived from it. As a resort for those who are convalescing from typhoid fever, diarrhœa, dysentery, and malarious diseases, the sea-shore is particularly to be selected.

Islands, when not of very great extent, are possessed of an average annual temperature much higher than neighboring places of the same latitude. Thus London is warmer than places of the same latitude on the continent of Europe, or

even than Paris, which is several degrees south of it. The influence of the warm currents of water which circulate around the island of Great Britain is undoubtedly the main cause of the greater amount of heat; but with all islands surrounded by large bodies of water the same effect results. The interiors of some islands are therefore excellent places of resort for those who are of a phthisical diathesis, and for whom an equable climate is necessary.

Cities.—The hygiene of cities is of itself a subject so extensive as to constitute a separate science, and we shall do no more than allude to a few points in connection with it which have a bearing on individual hygiene.

The temperature of large cities is, owing to the number of fires in dwelling-houses and factories, and to the vast extent of brick and stone walls which absorb heat, higher than the temperature of the surrounding country. The air is more impure, in consequence of the many sources of contamination which exist—the exhalations from numbers of inhabitants, the gases given off by factories of all kinds, the emanations from sewers and cess-pools, the immense amount of carbon from the fires of thousands of houses, all add matters to the atmosphere which render it more or less noxious in its character.

Owing to the obstructions to the free circulation of the air which exist, ventilation is not thoroughly effected, and the impurities are consequently retained, to exert their deleterious influence.

The mortality of cities is always greater than that of the country. Some of the diseases are almost peculiar to them. Such, for instance, is cholera infantum, which is best treated by sending the patient to the country. Malarious diseases do not prevail in the thickly inhabited parts of large cities, though by no means rare in the outskirts.

There are several other points connected with the hygiene of cities which will be considered under other heads.

The *food* and *drinks* which are peculiar to localities modify to a great extent the physiological and hygienic conditions of the inhabitants; but the full consideration of their influence is reserved for another division of this treatise.

CHAPTER X.

CLIMATE.

More has been written upon the sanitary influence of climate than upon any other subject connected with hygiene. The advantages of certain localities for certain diseases, the necessity for change of air for others, and the precautions to be observed by the invalids who seek health by a change of residence, have all been studied to an extent that has made us well acquainted with these subjects.

But it is not only in its influence over health that climate has been observed. Its physical relations have also engaged attention. Meteorology has made giant strides within the last few years, and not the least part of its progress has been directed to the elucidation of the vast questions connected with the influence of temperature, winds, water, electricity, altitude, etc., in the production of that condition which we call climate.

The word climate, (from κλιμα, a region,) if taken in its restricted sense, refers to one of the zones into which the earth from the equator to the poles was divided by the ancient geographers. But at present it is ordinarily used to mean the condition which results from the action of certain meteorological factors on the altitude, the soil, the position, and other telluric circumstances belonging to a region of

country. This condition influences the character of the vegetation, the animals, and the sanitary state of all individuals, either of the vegetable or animal kingdom of nature, which live under it. We find that a plant which flourishes in one kind of climate droops and withers when transplanted to another of different qualities; that animals brought from a climate to which they have been accustomed to one which is strange to them, sicken and die; and that the health and development of man are very greatly influenced by the character of the climate in which he is placed, especially if it be one to which he has not become habituated by long residence, or varying essentially from that under which his ancestors have lived.

We have already considered most of the agencies which contribute to the formation of climate, and we have only to point out how they are connected to each other in this relation, and the effects which result, in a hygienic point of view, from the various combinations of which they are susceptible.

As Humboldt* observes: "If the surface of the earth consisted of one and the same homogeneous fluid mass, or of strata of rock having the same color, density, smoothness, and power of absorbing heat from the solar rays, and of radiating it in a similar manner through the atmosphere, the isothermal, isotheral, and isochimenal lines would all be parallel to the equator. In this hypothetical condition of the earth's surface, the power of absorbing and emitting heat would everywhere be the same under the same latitudes."

Such a condition does not exist, and hence we find places of the same latitude differing from one another in temperature, degree of moisture, etc., and thus having different climates.

* Cosmos, vol. i. p. 324. Bohn's edition.

Climate is due to the latitude, the altitude, the nature of the soil, its vegetation and its state of cultivation, the situation with reference to oceans, lakes, or rivers, or to mountain ranges, and the character and direction of the prevailing winds.

Undoubtedly the most powerful cause of differences in climates is that of *latitude*, or distance from the equator. Classifying climates upon this basis, and they may be arranged into three divisions—the hot, the cold, and the temperate. But this division does not embrace all localities of the same latitude; for, from extreme height above the level of the sea in warm climates, or from the vicinity of currents of warm water (as the Gulf Stream) in cold regions, localities in the first instance are subjected to a climate where perpetual snow exists, and in the last are favored with such a moderate temperature as assimilates them to localities situated much nearer to the equator. We shall endeavor, in a general way, to point out briefly these disturbing influences as they affect some regions, which, but for them, would have the climate peculiar to their latitude.

Hot Climates.—The regions situated under the equator, and as far as 30° north and south of it, are subjected to the influence of a warm climate. At the equator the mean annual temperature is about 80° Fahrenheit, for the spring 84°, for summer 86°, for autumn 82°, and for winter 75°. In the sun the temperature is of course very much higher, reaching in summer, in some places, to 130°.

But within the lines of latitude mentioned as bounding the region where a hot climate prevails are found high mountain ranges, both on the eastern and western continents, on which all possible varieties of climate are to be found, from the hot which exists at the base, to the cold, characterized by the presence of perpetual snow. The vegetation, the animals, the diseases also change,

and are assimilated to those which pertain to higher latitudes.

On the coast of Peru, throughout a great portion of the year the thermometer is very much depressed, standing as low as 59°. According to Humboldt,* this effect is not to be attributed to the neighborhood of mountains covered with snow, but to the mist which obscures the sun's disk, and to a current of cold water coming from the antarctic regions and sweeping along the coast. This is cited merely to recall to mind the fact previously stated relative to the influence of water in modifying the temperature of the land.

The division of the tropical year into seasons is not so well marked as it is in more northern or southern latitudes. In fact, there is no winter, but instead there are six months of rainy season, during which the air is loaded with moisture, and the temperature reduced not more than ten degrees below the mean point of the summer months, which constitute the rest of the year.

There are differences to be observed relative to the effect of a residence in various parts of the tropics. According to the observations that have been made it would appear that America, within the tropics, is more healthy to Europeans than places of corresponding latitudes in either Asia or Africa. Africa is pre-eminently insalubrious, as is shown by the returns of sickness and mortality of the British army. Thus Colonel Tulloch states that from 1822 to 1830, 1658 white troops were sent to the British possessions in Africa, and that of this number 1298 died from diseases due to the climate, and the remainder, 387, were invalided home and otherwise accounted for. Of this number but 33 were reported as fit for service. Owing to this great mortality, it was determined to remove

* Ansichten der Natur.

the white troops and to substitute negro regiments, drawn from the West Indies, in their place. This was done, and with the effect of reducing very materially the amount of sickness and mortality.

The unhealthiness of the west coast of Africa is to be ascribed not only to the elevated temperature, but to the great amount of humidity, to the want of cultivation of the soil, and to the consequent rank vegetation which, decaying, spreads abroad its pestiferous exhalations.

Lind,* in referring to this region of country, says: "This wide extended coast appears, in most places, to be a flat country, covered with low suspended clouds. Upon a nearer approach, they are generally heavy dews, which fall in the night, and the land is every morning and evening wrapped up in a fog. Upon examining the face of the country, it is found clothed with a pleasant and perpetual verdure, but altogether uncultivated, excepting a few spots, which are generally surrounded with forests or thickets of trees, impenetrable to refreshing breezes, and fit only for the resort of wild beasts.

"The soil, like all other low lands, is either marshy or watered with rivers or rivulets, whose swampy and oozy banks are overrun with sedges, mangroves, and the most noxious weeds, on which there is a quantity of slime and filth that sends forth an intolerable stench, especially toward the evening."

Subsequently Lind states† that it scarcely admits of a doubt that if any tract of land in Guinea was as well improved as the Island of Barbadoes, and as perfectly freed from trees, shrubs, marshes, etc., the air would be rendered equally healthful there as in that pleasant West India island.

* An Essay on the Diseases incidental to Europeans in Hot Climates. London, 1768, p. 44.

† Op. cit., p. 51.

Daniell* also expresses the opinion that the extreme unhealthiness of Africa is due to the humidity of its atmosphere, conjoined with an elevated temperature and the presence of exhalations caused by the decomposition of a vast amount of vegetable matter.

In Asia we find the same causes in operation, though perhaps not to so great an extent. There the soil is more under cultivation, and there are high mountain lands in the interior which are as healthy as any other regions in the torrid zone.

Lind,† in speaking of this continent, says: "That the countries which are well improved by human industry and culture, such as China and several other places in that part of the world, are blessed with a temperate and pure air salutary to the European constitution. On the other hand, the woody and uncultivated parts of India, viz., the islands of Java and Sumatra, the islands of Negrais, where the English lately attempted to make a settlement, Banda one of the Dutch spice islands, and several others, have proved fatal to a multitude of Europeans and others who have been accustomed to breathe a purer air. But in all spots of the East Indies situated near the muddy and impure banks of rivers, or the foul shores of the sea, the vapors exhaling from the putrid stagnated water, either fresh or salt, from large swamps, from corrupted vegetables, and other impurities, produce mortal diseases, especially during the rainy season."

The diseases which are peculiar to the unhealthy portions of hot climates are of the same general type throughout the world, being mainly those which are due to malaria, but modified either in intensity or character,

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* Sketches of the Medical Topography and Native Diseases of the Gulf of Guinea, etc. London, 1849, p. 6.

† Op. cit., p. 76.

according to local circumstances. Thus, intermittent and remittent fevers of aggravated form occur in the West Indies and other parts of tropical America. Yellow fever prevails along the coast. Diarrhœa, dysentery, and liver diseases are also common and severe in their character. Dysentery is, according to Dutroulau,* the endemic disease of tropical climates from which the greatest annual mortality occurs; but this statement is not borne out by the statistical reports of the British army, from which it would appear that paroxysmal fevers give rise to more admissions into hospital and more deaths at the generality of stations in hot climates, garrisoned by British troops, than any other class of diseases. Ewart,† however, shows that in India the deaths from diarrhœa and dysentery are more frequent than from any other disease, but he also shows the great predisposing cause of these affections to be malarious fevers.

In tropical Africa malarious fevers and bowel affections are met with in their most malignant phase.

In those parts of the United States which are south of 30° of north latitude, severe intermittent and remittent fevers are encountered. Florida is peculiarly subject to malarious diseases. The character of the soil, and the absence of cultivation which prevail in the peninsula, call to mind the descriptions given by Lind and other writers of the west coast of Africa.

Cold Climates are those which prevail from 55° of north or south latitude to the pole. In these regions there is a very great range of temperature, and also very great differences to be observed in respect to other meteorological influences. Part of them are for a very considerable period

* Traité des Maladies des Européens dans les Pays Chauds. Paris, 1861, p. 442.

† A Digest of the Vital Statistics of the European and Native Armies in India, etc. London, 1859, pp. 42 and 86.

deprived entirely of the light and heat of the sun, and in others oceanic currents, of comparatively high temperature, lessen the degree of cold which would otherwise prevail.

According to the very extensive table prepared by M. Mahlmann, it would appear that Melville Island has the lowest mean annual temperature of any other place known to man, the thermometer indicating as the mean for the year 1·66°. The latitude of Melville Island is 74° 47′ north, and though more northern regions have been attained, (Dr. Kane having passed two winters at Renssalaer Harbor, latitude 78° 39′ north,) it does not appear that the average temperature for the year was lower than that observed at Melville Island.

The most moderate temperature met with within the limits embraced under the designation of cold climates, is that which prevails in the north of Ireland and throughout Scotland. And this fact is due to the circumstance that these countries are surrounded by the ocean, the water of which is rendered comparatively warm through the influence of the Gulf Stream, which preserves its elevated temperature till it reaches the shores of these countries.

In regard to vegetation, considerable variation is observed. In the localities within the limits in question nearest the equator, though not profuse it is not scant, but it is never of such a character as to exert any influence over the health of man by its decomposition, as is the case in the countries near the equator. As we proceed from this line north or south, the luxuriance of vegetable growth diminishes, until finally we arrive at regions where nothing but a few lichens or mosses are to be found.

In Norway, in the valley of the Alten, at 70° north latitude the soil admits of cultivation. In no other part of the globe with this latitude is the earth tilled, and to the

influence of the Gulf Stream must be ascribed the isolation of this spot from the concomitants of other localities situated within the arctic circle.

In America at this latitude the climate is such as to admit of the production of nothing beyond fucoid growths, and in Siberia a similar condition exists.

The Danish settlements in Greenland are still farther north, Upernavik at 72° 40′ and Tessuissak at 73° 40′; but though men are capable of maintaining themselves in these inhospitable places, they are unable to procure from the earth any portion of their subsistence. Even as high as 78° of north latitude, Dr. Kane met with a tribe of Esquimaux, entirely shut off from all communication with the rest of the world, and numbering but a little over one hundred persons.

To what are we to ascribe the stunted forms of the inhabitants of these regions but to the degenerating influences of low temperature, deficient light, and insufficient food? The struggle with nature for existence appears to be constant; and yet when we come to examine into the sanitary condition of these people, we really find very little to exert an injurious action upon them except those causes which arise from their own depraved habits of life. Malarious diseases are unknown, phthisis is scarcely if ever heard of. Civilization has not reached them, bringing in its train a thousand ills that owe their existence to the violation of the laws of hygiene. Though their huts are reeking with filth, though in their personal habits they have no idea of cleanliness, the emanations which would otherwise be noxious are deprived of their injurious qualities by the low temperature that prevails, and, save the danger from cold and starvation, they are exposed to scarcely any morbific influences. Those diseases which do affect them are not of the sthenic type, and are limited to low fevers, to which they are occasionally liable.

Hans Egede,* a missionary in Greenland for twenty-five years, in a quaint description of that country, says: "The temperament of the air is not unhealthful, for if you except the scurvy and distempers of the breast, they know nothing here of the many other diseases with which other countries are plagued; and these pectoral infirmities are not so much the effect of the excessive cold as of that nasty foggish weather which this country is very subject to."

But those to whom the arctic climate is not natural bear its rigors with great difficulty, and combat against a constant tendency to break down under its depressing power. At Kjevik in Norway, which is the most northern point of Europe inhabited by civilized people, according to Mr. Bayard Taylor missionaries coming there from southern Norway die within the year, and half the inhabitants perish annually of scurvy. Attempts have been made to colonize Jan Mayen and Spitzbergen, but they were unsuccessful; and some Russians who were left at Spitzbergen for six years died, with the exception of four, before the expiration of the first winter.

It must not be forgotten, however, that this inability of Europeans to exist for any length of time in arctic regions is not altogether due to the influence of climate. It is the result of the attempt being made without the mode of life being adapted to the changed conditions under which the organism is placed. Scurvy appears to be the disease which is most fatal to arctic voyagers, and yet it is altogether possible to prevent the occurrence of this affection, as did my friend Dr. Hayes, now of the United States Army, during his recent polar expedition. Dr. Hayes attributes the entire freedom of his command from scurvy to the fresh meat diet which he was able to obtain for his

* A Description of Greenland, etc. Translated from the Danish. London, 1745.

men, and to the thorough ventilation of his vessel during the winter, when the party were confined, to a great extent, to this shelter.

In latitudes characterized by an extreme depression of temperature the food must be essentially different from that most in use by the inhabitants of tropical climates. We know that one of the chief sources of the animal heat is the oxidation of carbon and hydrogen in the blood and tissues. In hot countries the inhabitants seldom eat meat or fatty substances, their inclinations and instincts pointing to the use of fruits and light farinaceous articles of diet. Here any exertion of the organism to keep up its normal temperature is unnecessary, for the atmosphere is almost constantly possessed of such a degree of heat as militates against the loss of any but a very small amount by the body.

On the contrary, in cold climates the circumambient atmosphere is, as we have seen, frequently 150° below the temperature of the body, which, therefore, is constantly losing its heat to such an extent as would in a very short time lead to death but for the character of the food used by those who are subjected to this extreme degree of cold.

The well-marked variations which indicate the seasons intermediate between winter and summer are not witnessed in cold climates. In arctic or antarctic regions summer and winter are the only two divisions of the year which exist. On this account the great amount of sickness which results in temperate climates from the changeableness of the weather is not met with in cold climates.

Thus we see that though the inhabitants of arctic and antarctic regions evidence in their physical and mental development the operation of the meteorological and telluric influences to which they are subjected, so far as their individual hygienic condition is concerned they are far more favored than the dwellers in tropical climates, who are surrounded with almost innumerable sources of disease.

TEMPERATE CLIMATES.—The regions north and south of the equator, extending from the thirtieth parallels of latitude to the fifty-fifth, exhibit to some extent the characteristics of climate belonging to both the torrid and the frigid zones. In summer the heat in some localities rises to as high as 105° Fahrenheit, and in others in winter falls to 40°. Even in the same place the range of temperature may be greater than is ever observed in the torrid or frigid zones. Thus at Fort Kent in Maine, latitude 47° 15′ north, the lowest temperature observed during February, 1845, was 39°, while in July of the same year a maximum point of 90° was reached, showing therefore a range of 129°.*

In temperate climates the seasons glide almost insensibly into each other, yet from day to day of any portion of the year great variations are often experienced. In the United States, for instance, it is not uncommon to experience a difference of thirty or forty degrees between the temperature of one day and that immediately preceding or succeeding it.

Temperate climates allow of luxuriant vegetation in those parts nearest the equator, and even in those farthest from this line the earth yields abundantly both for the subsistence and comfort of man. During the spring, summer, and autumn, throughout nearly their whole extent, malarious fevers prevail, and in the warmer portions assume a malignant type, scarcely inferior to that met with under the equator. But with the approach of winter diseases of this character disappear, and do not originate while the temperature remains below 32° of Fahrenheit.

In considering the peculiarities of temperate climates we shall dwell particularly on that of the United States, not

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* Army Meteorological Register for Twelve Years, from 1843 to 1854 inclusive. Washington, 1855, pp. 122, 142.

because it is a type of others of the same class, but on account of the greater interest which attaches to it among those for whom this book is mainly intended. So far from the climate of this country being a standard by which to judge those of other countries embraced within the same parallels of latitude, it presents more variations, more inconsistencies, than that of any other country on the face of the globe.

The climate of the United States is colder than that of European regions of the same latitude, but warmer than places similarly situated in Asia. Thus the fortieth parallel of north latitude passes through Philadelphia, and the forty-first a few miles north of Naples. The mean annual temperature of the former place is 54·57°, as determined from observations extending over six years, while of the latter it is 62·06°, as deduced from observations continued through eighteen years. The fortieth parallel also passes through Pekin, but here the mean annual temperature is but about 52°.

Fort Snelling, situated in latitude 44° 53′ north, and but eight hundred and twenty feet above the level of the sea, has, as the mean of observations extending over thirty-five and three-quarters years, an annual temperature of 44·54°,* while Sevastopol, which is situated in latitude 44° 36′, has a mean annual temperature of 52·7°, and London, which is in latitude 51° 31′, nearly seven degrees north of Fort Snelling, has an average annual temperature of 50·7°, or nearly seven degrees above that of the latter place.

To account for the greater temperature of Europe, several theories have been proposed: one of them ascribes the difference to the greater extent to which the soil is cultivated, and doubtless this influences the result to some extent, but it is not sufficient to account for the great differ-

* Army Meteorological Register, p. 632.

ence. More probable causes are to be found in the facts that the prevailing winds of Europe come from the Atlantic Ocean, and, being loaded with moisture, give out their latent heat as the vapor they carry with them is condensed into rain, and that the Gulf Stream, rushing out of the Gulf of Mexico, heated to over seventy degrees, sweeps along the northern coasts of Europe and modifies the temperature which would otherwise belong to these regions.

Moreover, on referring to the map it will be seen that Europe extends north but to about the seventy-first degree, and is then bounded by an open ocean; whereas the continent of America extends as far north as the eightieth degree, and is inclosed by a sea of ice. From this region cold winds proceed, untempered by passing over any intervening water, and reduce the temperature of the whole of North America.

But if we take the western coast of the United States, we find the climate very much modified in severity, and more nearly comparable with that of the west coast of Europe. Thus Fort Vancouver, in latitude 45° 36′, has a mean annual temperature of 52·65°, and Venice, in latitude 45° 26′, an average temperature for the year of 56·6°, a difference of only four degrees. Fort Steilacoom, in latitude 47° 10′, possesses a mean annual temperature of 50·82°, and Baden-Baden, in latitude 47° 30′, nearly the same, 50·5°.

Upon examining the isothermal charts, prepared by Mr. Lorin Blodget for the *Army Meteorological Register*, it will be seen how the temperature lines change their latitude as they pass across the continent.

As an example, take the line representing a mean temperature for the year of 50°. Commencing at Fort Adams, in latitude 41° 29′, it proceeds in a direction generally parallel to the equator, till it reaches the great sandy plains of the eastern slope of the Rocky Mountains. It

now inclines to the north, and arrives at Fort Laramie, in latitude 42° 12′. It now suddenly turns to the south, and runs along the table-lands of the Rocky Mountains till it reaches Las Vegas, in latitude 35° 35′, having lost 5° 09′. Crossing the mountain chains of New Mexico in a direction nearly due west, it abruptly turns to the north, and, running in a direction about north-northeast, crosses the fiftieth parallel, having gained 8° 51′ of latitude since it left Fort Adams, and having passed through 15° of latitude.

In regard to humidity the greatest difference exists. At Fort Yuma, in the interior of California, the mean amount of rain for the year is but three inches, while at Baton Rouge in Louisiana, Fort Myers in Florida, and the northern coast of Oregon, the quantity for the year is sixty inches. On the dry and sandy plains of western Kansas and New Mexico dew is never seen; in the eastern parts of the country the air for weeks together is loaded with moisture.

In the characters of the *soil* and in the *geological formation*, every variety is to be met with. In Florida, marshes; in Louisiana, alluvium; in the Middle and Western States, a rich humus; in New Mexico, sand, are the features encountered.

In *altitude* above the sea, the whole surface of Florida will not average fifty feet, while that of New Mexico reaches to between four and five thousand.

In regard to the diseases which arise under these varied conditions, the *Medical and Statistical Reports of the Army*, prepared, from data furnished by the medical officers, by Lieutenant-Colonel R. H. Coolidge, M.D., Medical Inspector, furnish the most extensive and reliable information, and are well worthy the careful study of all those who desire to understand the diseases to which our soldiers are liable.

In Florida the ratio of cases of fever treated to 1000 of

mean strength was 2216, while in New England it was but 114. In diseases of the organs connected with the digestive system, Jefferson Barracks, St. Louis Arsenal, and the east coast of Florida have the greatest ratio, and the coast of New England the smallest. In diseases of the respiratory system, New York, New England, and the region about the great lakes exhibit the largest ratios, and Florida, Texas, and New Mexico the smallest; while for all diseases the south and west, as far as the Mississippi River, exceed other portions of the country.

Another most interesting point settled by these statistics is that relative to the influence of climate over phthisis. The following table is so important in the indications which it affords that I have not hesitated to transfer it from the volume in which it originally appeared.*

Regions.	Mean strength.	Number treated.	Deaths.	Ratio of cases per 1000 of mean strength.
Coast of New England	3968	19	5	4·8
Harbor of New York	9887	56	35	5·9
West Point	6901	6	8	0·8
North interior East	3553	17	10	4·7
The great lakes	10,346	47	33	4·5
North interior West	7230	30	15	4·1
Middle Atlantic	6299	16	14	2·5
Middle interior East	2456	6	8	2·4
Newport Barracks, Kentucky	1454	5	4	3·4
Jefferson Barracks and St. Louis Arsenal	5580	23	21	4·1
Middle interior West	5319	28	13	5·2
South Atlantic	2800	26	5	9·2
South interior East	5919	43	28	7·2
South interior West	10,018	20	25	2·
Atlantic coast of Florida	885	2	1	2·3
Gulf coast of Florida	2299	16	8	6·9
Texas, southern frontier	4450	18	11	4·
Texas, western frontier	6824	25	12	3·9
New Mexico	5878	8	3	1·3
California, southern	1707	9	5	5·2
California, northern	1599	9	4	5·6
Oregon and Washington Territories	1831	6	2	3·2

* Statistical Report on the Sickness and Mortality of the United States Army, from January, 1839, to January, 1855. Prepared by R. H. Coolidge, M.D., etc. Washington, 1856.

From this table it is seen that with the exception of West Point (which should be excluded, for the reason that the cadets are young men who undergo a rigid physical examination before they are allowed to enter the military academy as students) the lowest ratio of cases of consumption occurs in New Mexico, being only 1·3 per 1000, and that the highest is in the South Atlantic Region, where it is 9·2 per 1000.

From a careful examination of the tables of temperature, rain, and weather, which have been formed from data collected by the medical officers, and considering them in connection with the results exhibited in the foregoing table, there can be no doubt relative to the correctness of the conclusions arrived at by Dr. Coolidge.

"*First.* That temperature considered by itself does not exert that marked controlling influence upon the development or progress of phthisis which has been attributed to it. If a high range of temperature were favorable to the consumptive, the South Atlantic Region, the South Interior East, and the Gulf Coast of Florida should exhibit a lower ratio than the colder regions of the north and northwest, whereas the contrary obtains; and again, if a high range of temperature were the controlling element in causing an increased ratio of this disease in the two southern regions above named, we ought *not* to find a lower proportion of cases in Texas, where the temperature is higher, nor in the South Interior West, where it is nearly the same as in the South Atlantic Region.

"*Second.* That the most important atmospherical condition for a consumptive is DRYNESS. An examination of the rain tables will serve in part to elucidate this position, and in part only, for the total annual precipitation in rain and snow may be equal in two or more places, and yet the annual condition of the air, as respects moisture—the dew-point—may widely differ. It is impossible to repre-

sent all their distinctive features by statistical tables, but the fact has been forcibly impressed upon the compiler during the minute examinations necessary to the preparation of this report.

"*Third.* That next to DRYNESS in importance is an equable temperature—a temperature uniform for long periods, and not disturbed by sudden or frequent changes. An uniformly *low* temperature is much to be preferred to an uniformly *high* temperature. The former exerts a tonic and stimulating effect upon the general system, while the latter produces general debility and nervous exhaustion. The worst possible climate for a consumptive is one with a long-continued high temperature and a high dew-point."

From my own observation, I am able entirely to confirm the deductions arrived at by Dr. Coolidge. I have known several persons affected with phthisis pass the winter at Mackinac with very decided advantage. The climate there is cold and dry. The mean temperature of winter, as deduced from observations made during twenty-four years, is 20·03°, and for the whole year 40·65°. The mean quantity of rain for the same season (snow being melted and measured as water) is but 3·31 inches, and for the whole year but 23·87 inches; less than the average at any other military station of the United States, except those situated on the prairies west of the Mississippi and in New Mexico, and some parts of California and Oregon. Under the influence of the climate of Mackinac, both in summer and winter, I have witnessed all the symptoms of phthisis become ameliorated or entirely disappear, at the same time that the body improved in condition and strength. Of course, in cases in which the disease was far advanced, the same favorable results were not to be expected; but even here a very marked improvement was manifested.

As the foregoing table shows, however, New Mexico is by far the most favorable residence in the United States for

those predisposed to or affected with phthisis. Surgeon J. F. Hammond* remarks, in his report on the Medical Topography and Diseases of Socorro, that he had never seen but two cases of phthisis in New Mexico. One of these was that of an officer in the army, and the other of an American emigrant. Both were affected before leaving the United States, and both improved under the influence of the dry and equable atmosphere of New Mexico.

In a service of three years in New Mexico, during which period I served at eight different stations, ranging from the extreme northern to the extreme southern part of that Territory, I saw but three cases of phthisis, and these were in persons recently arrived from the United States. Inflammation of the lungs is also very infrequent, as are likewise pleurisy and bronchitis.

Contrary to what would be expected, acute rheumatism is quite a common disease in New Mexico, especially among those who have emigrated from the United States.

Enough has probably been said to give the student some idea of the variations of climate and the diseases to which the inhabitants dwelling under each kind are peculiarly liable. For fuller information on the subject, he is referred to the work of the late Dr. Samuel Forry, U. S. Army, on the Climate of the United States, to the several volumes of Army Medical Reports, and to the works of Sir James Clark, Mr. Edwin Lee, Sir Ranald Martin, and others.

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* Army Medical Reports, from 1839 to 1855, p. 425.

CHAPTER XI.

ACCLIMATION.

By acclimation we understand the process by which an individual becomes naturalized to any particular climate to which he is not accustomed. Through the change which ensues, his system becomes assimilated to the type which predominates among the natives of the region. He acquires their peculiarities and immunities, and in fact, if the act of acclimation is thorough, undergoes a change both in his mental and physical organization.

That this process does take place, there can be no doubt, so far as individuals are concerned; but there are not wanting those who contend that races never undergo complete acclimation, that degeneration invariably occurs, and that those nations who have colonized regions with different climates than those from which they originally sprung, would inevitably become extinct but for the engrafting of new blood by emigration from the parent countries.

There is no evidence to support this view. On the contrary, the whole history of the world is against it. It needs but a superficial examination of the people of this country or of England, for instance, to show its utter want of foundation. The present inhabitants of the British Isles are not autochthones, (αὐτός, one's own, and χθων, land, country,) and yet no one, we presume, would venture to assert that they are physically or mentally inferior to those of their neighbors who are original stocks. The present inhabitants of the United States are of European descent,

and are mainly natives of the soil, the emigration not being sufficient in a generation to make any decided impression. In stature, in girth of chest, in powers of endurance, they will compare favorably with the inhabitants of any country in the world. In fact, as the result of over fifteen thousand observations, embracing the chief points desirable in a collection of vital statistics, I am enabled to assert that so far as physical development is concerned, it is very doubtful if any people in the world excel those of the Northern States.

Take, also, the instance of the Jews. Originating in Eastern Asia, they have spread over the whole world, assuming the type of organization peculiar to the people among whom they fix themselves, but retaining their physiognomy to such an extent that no one has any difficulty in recognizing them.

But the ability to become acclimated is not possessed to the same extent by all races. We have already seen that the Caucasian race is pre-eminent among all others for its capacity for colonization, and consequent power of adapting itself to the peculiarities of climate. We see it in all parts of the world, from regions of perpetual ice and snow to the torrid zone where frost is never seen, able to combat successfully the various climatic influences by which it is surrounded, and to adapt its peculiarities of organization to the new conditions, *provided changes are made in the mode of life, manners, and customs of those who essay the experiment.* This is the main point. For an Englishman or an American to attempt a residence in latitude 80° without varying his food, clothing, or habits, by making them conform to the climate to which he has come, would lead but to one termination—death. But if he studies the conditions by which he is surrounded, and profits by the experience of those to whom they are natural, he becomes habituated to the new state of things, and lives in health and comfort.

Instances of the truth of these propositions are not

wanting. Formerly expeditions to arctic or antarctic regions lost many of their number from inattention to this law, or ignorance of its existence; but now they pass winter after winter surrounded by ice, and with the thermometer for months together at —40°, without the loss of a man, except by accident.

So, also, with those who change to a hot climate, the same law holds good. Copland* states that when traveling in intertropical Africa in 1817, he met with an Englishman who had lived there for between thirty and forty years, and was then in the enjoyment of health. The circumstance appeared singular, and, in answer to inquiries, the resident stated that soon after his removal to that pestilential climate, his health continued to suffer, when, after trying various methods without benefit, he had pursued as closely as possible the modes of life of the natives, adopting both their diet and beverages, and since that time he had experienced no serious illness.

In the following passage from Lévy,† this subject is so well considered, that I translate it entire:—

"Has man sufficient organic flexibility to adapt himself by turns to extreme influences of diverse orders, and thus to flourish under all climates? Those who adopt this opinion refer to the diffusion of the human species from 60° of south to 70° of north latitude. Man lives at altitudes of 4101 metres, in deep excavations of the soil under a pressure of the atmosphere superior to that at the level of the sea. He has lived for a short time far above this limit. Saussure in the Alps, Bonguer in the Cordilleras, have reached heights of about 6000 metres; Parry and others have opened a way through the ice beyond 82° of north latitude. Thus man exists in the midst of a tem-

* Dictionary of Medicine, vol. i. p. 409, art. *Climate.*

† Traité d'Hygiène, tome i. p. 563.

perature exceeding that of his own blood. He triumphs over a degree of cold sufficient to freeze mercury. His existence is not immediately endangered by a pressure less than half of that which he supports at the surface of the earth—at altitudes where water boils at 66·66° Centigrade, and under an atmospheric pressure equivalent to but half of that which obtains at the level of the sea. Those who refuse to man the faculty of living and of perpetuating his species under all latitudes, affirm the multiple formation of mankind, insist on the differences of races, and on the fatal results which ensue on translating man from one climate to another. Three hundred Germans sent to Cayenne in 1765 were reduced in less than three months to three individuals, of whom only one had escaped disease. Seven hundred Frenchmen, deported to a district of Mexico by M. Laisné de Ville-Lévesque, lost in two years five hundred and thirty of their number by death. According to Lind, the new-comers in the Antilles, even when taking all proper precautions, succumb in the proportion of one-fifth every year. Dr. Twining, who has practiced a long time in India, assures us that the influence of the climate is such that in the peninsula of the Ganges the third generation of pure, unmixed Europeans does not exist. This remark applies both to the English and the Portuguese. Negroes resist a little better, but nevertheless perish very rapidly. It is the same in Ceylon. From 1730 to 1752 more than a million of colonists perished in Batavia. The English army loses in that country, and in time of peace, 1·2 of 100 officers, and 1·7 of 100 soldiers. In the Indies the same troops experience a mortality threefold greater, according to a mean of three years, established by M. Edmondre. In the English Antilles, the calculations of MM. Marshall and Tulloch fix the proportion of deaths among the troops at 1 in 24; it is increased in Senegal to 1 in 7. (*Thévenot.*) It would be very easy to multiply the

examples of this excessive mortality observed with individuals who have been transported to different countries; but all the facts of this kind, accumulated by statistics, prove nothing against the aptitude which man possesses to support very different climates; for it is necessary to demonstrate that the mortality should be attributed exclusively to the influence of climate. As to the extinction of emigrants to the second or third generation, has it been the certain consequence of the attempt at acclimation in intertropical regions, or has it not rather been the general episode of attempts at colonization made without prudence in countries of notorious insalubrity? Had the Europeans, whose posterity has disappeared so rapidly before the scorching atmosphere of the tropics, acquired (with the evidences of a complete acclimation) the power to procreate offspring adapted to the climate in which they were born? Before engendering new beings for a region in regard to which they were inexperienced, had they undergone the series of transformations which would enable them to live there themselves? Had the children received the attention and the hygienic direction which the climate prescribes? What has been the hygiene of the colonies thrown without care from Europe to the Antilles? What is to be conceived of the deplorable condition of the emigrants whom misery drives in crowds from their native soil, and who, from the time of their embarkation for their distant destination, suffer under the pangs of nostalgia and from the fatigues and deprivations of a long voyage? Who does not know the excesses, the singular eccentricities, the injurious customs which lie heavy on the life of the English in India? Johnson draws the picture, worthy of pity, which they present: imprisoned by a tyrannical custom in the vice of their tight-fitting uniforms, they are inundated by the floods of sweat which pass through their clothing."

In considering further the subject of acclimation, it will be proper to discuss it under two heads—as it is connected with the removal of individuals from a cold to a warm climate, and its relations to the change from a warm to a cold region. The food which an individual should ingest, the drinks which he should imbibe, when he is subjected to a change of climate, will be mentioned briefly; the full consideration of food in all its bearings being reserved for another division of this treatise.

1st. *The acclimation of individuals removing from a cold or temperate to a hot climate.*

It is necessary, in the first place, that we should perfectly understand the primary physiological effect produced upon the human constitution by passing from a cold to a hot climate.

In the inhabitants of cold regions the vital functions are maintained in a highly active condition. The heart beats full and strong, in order to force the warm blood through every part of the body, and thus to preserve the animal temperature at its proper point. The respiratory process is also conducted with energy; digestion is promptly performed; the kidneys are active in removing the effete matter which, from the vigorous manner in which the organs act, is formed in great amount. The whole organism is thus adapted in its functional operations to the condition of climate under which it exists.

Transfer a person whose system has become habituated to a cold climate to one that is torrid in its character, and he is at first unsuited for the new conditions which surround him. It is not necessary that his circulation and respiration should be as active as before. The temperature of the air is as high as that of his body, and consequently, even if life were to become extinct, the thermometer placed in the cavity of his chest would stand at the point indicating the temperature of the circumambient

air. There is therefore a surplus of action in the functions of circulation and respiration. But there is no excess in actual results. The hot and moist atmosphere is calculated to interfere with the due performance of those changes which are carried on through the respiratory process, and the products of tissue metamorphosis, which were removed to a great extent from the system by the lungs, are either retained in the body or thrown upon the liver for excretion. This organ therefore becomes disordered. To perform the increased amount of labor which it has to undertake, it becomes enlarged, in accordance with a well-established law of the economy.

The skin, which in cold climates ordinarily performs its function insensibly, becomes very active; the kidneys, on the contrary, excrete less than previously.

Through the increased action which ensues in the functions of the liver a large amount of bile is poured into the alimentary canal, to give rise to intestinal diseases, or to be reabsorbed into the economy, causing fever and other forms of constitutional disturbance.

Food.—If, in addition to these perfectly natural causes of disordered action in the organism, food and drink, such as the individual may have been accustomed to, is now indulged in, the disturbance is very much increased. All writers on the diseases of warm climates insist upon the absolute necessity of temperance. Mosely* says, in speaking of the climate of the West Indies: "On first arriving, though the use of the necessaries of life and the natural gratification of natural desires are by no means interdicted in hot climates, yet every excess is dangerous; and temperance in all things is necessary to be observed by men, women, and children. For youth, abstemiousness for awhile is the best security against illness."

* A Treatise on Tropical Diseases. London, 1788, p. 13.

Lind* refers to the irregularities of young people wh. go to the East or West Indies as one of the principal causes of the sickness to which they are subject. "For," as he says, "if those who are newly arrived at Jamaica drink immediately of hot, new-distilled rum, they will unavoidably fall into a violent fever; if they commit any excess in eating fruits, they will have a flux; or if they load their stomach with indigestible food, they will have a cholera morbus or a vomiting, which may carry them off in a few hours."

M. Aubert-Roche† also observes that diarrhœa, dysentery, and hepatitis occurring in Europeans are mostly traceable to errors in diet. Habituated to the use of wine and other stimulants, they persevere in drinking them, or substitute arrack in their place. Ignorant of the effects of alcoholic drinks in warm countries, oppressed by the heat, and weakened by the excessive cutaneous transpiration, they drink and expect to restore their strength by frequent potations. But so far from being a tonic under these circumstances, alcohol acts as an irritant to the stomach, and an exciter of those very actions which, as has been seen, are already performed with too much energy. Even in cold climates alcohol, when used to excess, acts injuriously upon the liver, and in hot countries its influence is still more prejudicial. Dutroulau‡ also calls attention to the injurious results of over-eating. He says that excesses of the table are those which the newly arrived European in hot climates should take most pains to avoid. Regularity of regimen is the first means which

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* An Essay on Diseases incidental to Europeans in Hot Climates, etc. London, 1768.

† Essai sur l'Acclimatement des Européens dans les Pays Chauds Ann. d'Hygiène, 1845, tome xxxiii. p. 25 et seq.

‡ Traité des Maladies des Européens dans les Pays Chauds. Paris 1861, p. 123.

he should employ in order to aid the stomach in passing through the modifications which it is obliged to undergo. His drink, if he takes any alcoholic liquor at all, should be wine and water. It is doubtful if pure red wine, taken with moderation, can be considered hurtful.

Don Abel Victorino Brandin,* in an excellent little work, is very specific on this point, and being himself an inhabitant of the torrid zone his opinions possess additional value. According to this author, one should eat less in hot than in cold climates, and excesses in this direction are more dangerous in the former than in the latter.

Almost all writers on the diseases of hot climates recommend the use of coffee as a beverage.

In general terms, Europeans emigrating to hot climates should avoid the ingestion of any substances calculated to disorder the action of the stomach or other viscera concerned in the function of digestion. Their food should be unstimulating, and, as far as practicable, should be analogous to that of the residents of the region. Fruits and amylaceous substances are those which experience has found to be most beneficial, the former at first being used moderately. Acid drinks, unless used in small quantity, are injurious, as tending to induce intestinal disturbance.

Troops on service in hot climates should be guided by similar principles. If possible, fresh meat should be issued at least three times a week; alcoholic liquors should be altogether interdicted, and the use of coffee encouraged, especially in the morning. Fortunately there is no necessity for insisting on the advantages to the troops of coffee as a beverage. It is always provided for them, and is generally of good quality. Tea is also an excellent drink, and produces results analogous, though not identical, with

* De la Influencia de las differentes Climas del Universo sobre el Hombre. Lima, 1826, p. 110.

those caused by coffee. This subject is reserved for further consideration under the head of aliments.

Exercise.—Much physical exercise is injurious to those newly arrived in hot climates. Aside from the exposure to the heat of the sun, or to the noxious night air which it generally necessitates, it is debilitating until the system has become habituated to the altered relations in which it is placed.

Mosely,* in alluding to this subject, asserts that discipline should never be of that character or degree to exceed the proportion of exercise which is conducive to health. A soldier should be nursed. All drudgery should be performed by negroes and others inured to the climate; and a soldier should be allowed to perform no exertion until some important point is to be carried into execution. Drills should be in the morning before the sun has acquired its full power, but not until it has risen sufficiently high to dissipate the noxious emanations which have been given off from the earth during the night.

Work requiring the turning up of the soil is, for the reasons stated under the head of malaria, especially prejudicial. With troops, however, it is not always possible to avoid those labors which are often dictated by a military necessity.

At the same time idleness should not be tolerated. Nostalgia, which has its most frequent cause in habits of idleness, is one of the chief occurrences to guard against in acclimation. Moderate exercise is to be encouraged, both as being beneficial to the body and the mind, but it should be of such a character as not to produce fatigue. At garrisons, games in the open air, toward sundown, (not after,) afford means of amusement, and of providing sufficient physical exercise.

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* Op. cit., p. 133.

Clothing.—The clothing should be light, and at the same time sufficiently fine in texture, and of such a character as to prevent the too rapid refrigeration of the body during the cool nights which so frequently, in warm climates, ensue upon the excessively hot days. Flannel worn next the skin is very useful, acting both as a moderator to the body and the atmosphere, preventing the former losing its heat too rapidly, and also from becoming overheated. Men who wear flannel underclothes can endure much more fatigue than those who make use of no such protection. I have witnessed many instances of the truth of this assertion, and also of the fact that men wearing flannel immediately next the skin are not so liable to the diseases ordinarily attending acclimation, such as dysentery, diarrhœa, malarial fevers, etc., as those who do not.

Mosely* states that Dr. Irving, with a small party of men, lay in the woods on the Mosquito shore for fourteen days and nights, during the rainy season of 1780, without taking off his clothes, while he was exploring a passage to the Spanish settlements up Bluefields River. He escaped without the least injury to his health, having blankets with him, and being clothed in a shirt, short jacket, breeches, and stockings, all made of flannel. The others, not using the same clothing, suffered severely, without exposing themselves to the same fatigue or danger.

The United States troops are furnished with flannel shirts, and it would be well if the drawers were made of the same material. The thick blue cloth coats and trowsers are not suited to warm climates; neither is the cap which is now worn at all adapted to service, either in hot or cold regions. In the Southern States, broad-brimmed straw hats should be issued for summer use, as was done last summer at Hilton Head by Major-General Hunter.

* Op. cit., p. 132.

The British troops in the West Indies are, I believe, at present clothed in white duck through the hot season. The subject of clothing, in all its details, will be more fully considered hereafter under its proper head.

Baths.—Owing to the great activity in the excretory function of the skin, and the consequently increased amount of matter left upon its surface, baths are even more necessary to health than in temperate climates. At first they should be tepid, and the temperature should be gradually lowered till the point of 75° or 80° is reached. They should be taken in the morning before breakfast, according to the rule already laid down. The cold bath, aside from its cleansing properties, is one of the best means of fortifying the system against the diseases to which recent comers to a hot climate are liable.

Localities.—There are generally to be found some places, even in the most unhealthy climates, which, if not altogether healthy, are at least more so than others. These should always be taken advantage of for the location of barracks, camps, or hospitals. Many lives have been lost by a stubborn adherence of the British authorities to locations notorious for their insalubrity, and which had been over and over again reported by the medical officers as exposed to the most noxious influences, when other and healthier places, equally advantageous in a military point of view, were at command.

From a neglect of the precautions specified, thousands of lives have been sacrificed which might have been otherwise preserved. The care of the health of the troops should certainly be one of the first duties of a military commander. Unless his men are in good physical condition, they can be of no service to him in carrying out the objects he may have in view, but are a hinderance to him and a burden to themselves. And yet how often it happens that those in command are heedless of the warnings and inattentive to the advice given by their medical officers!

The Crimean war taught a lesson to the British Government which it has not been slow to profit from, and which, although it has proved advantageous to us, we might still further appropriate to ourselves. When an English army goes to a foreign climate, an officer of the medical department is specially assigned to duty with it as sanitary officer. It is the duty of this officer to advise the commander on all questions affecting the health of the troops. He has nothing else to do but to attend to this duty.

During the late expedition to the north of China an opportunity was afforded for carrying out the regulations previously framed relative to the sanitary officer. Dr. Rutherford, Deputy Inspector-General of Hospitals, was assigned to this duty, and, if we may judge from his report,* performed it with credit to himself and advantage to the force with which he served. To Lord Herbert, who, when he died, was Secretary of State for War, the medical department of the British army owes much of the progress which has characterized it since the war with Russia, and his influence has been felt far beyond the limits of his own country.

Acclimation, when thoroughly perfected, assimilates the individual to the indigenous inhabitants of the soil in the peculiar type of his organism. His system has undergone some change by which he has become possessed of certain attributes in place of others which he has lost. The number of years required to effect this reorganization varies according to the latitude; a longer time being required in proportion as the region is nearer to the equator.

In military affairs, it is of course desirable to take advantage of this faculty of becoming acclimated, and to change the troops in service in hot countries as seldom as

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* Statistical Sanitary and Medical Reports of the British Army for the year 1860. London, 1862, p. 291.

possible. A better plan is to follow the system adopted by the English Government, and to garrison stations in hot climates with troops raised in great part from the inhabitants of the countries where they are situated. In sending troops to a hot climate, the best season for their arrival is at the commencement of winter, as then a longer time is afforded, before the beginning of the sickly season, for the system to become gradually habituated to the ordinary influences.

The permanent effects of change from a cold to a hot climate, if fully discussed, would lead us into the realm of ethnology. It will be sufficient if we merely point out some of the more prominent changes which ensue after several generations are exposed to the effects of a residence in a hot climate.

The heat and light of the sun change the color of the skin and hair, rendering the one black and the other nearly so. There are also other changes effected through the long-continued influence of these agents, as well as by the increased moisture, the different food, the entire change in the mode of life, which are accompaniments of a hot climate. None of these are, however, of such a character as to cause a race of men to lose their identity. The Jews of India are almost black; those of Europe assimilate, in the colors of their hair, eyes, and skin, to those of the nations among whom they live. But the form of the cranium and the peculiar physiognomy are preserved, so that, notwithstanding the color, it is very easy to recognize a Jew by these last-named characteristics. As to the lengthening of the arms, the flattening of the calcaneo-tarsal arch, the backward prolongation of the os calcis, the curvature of the tibia, etc., there is no evidence to show that they are at all due to the effect of climate. They are typical characteristics of the races in which they are found.

It has been too much the fashion to attribute all the differences which exist among men to the effects of climate. This is most illogical. We know that climate will effect many changes; but we know tolerably well what those changes are. The history of the past is written both in the monuments of the historic and the pre-historic man, and no fact is more indubitably established than that of the invariability of types. In non-essentials, such as the color of the skin and its appendages, there is variety; but in all the essential characters, such as the form of the cranium, the shape and size of the features, and the mental organization, climate exercises but little influence.

Those who deny the capacity of man for acclimation, appear to forget that nearly all our domestic animals are not indigenous to European or American soil. Why they should admit that the horse, the dog, the cat, the ass, the hog, and others, have been brought from climates far different from those under which they now flourish, and refuse to allow the same power of adaptation to man, is difficult to understand. So also with our vegetables and fruits; many of those which we prize most being originally natives of other climates. The acclimation of plants is of course more difficult than that of animals, as the character of the soil is to be taken into consideration, as well as the meteorological influences. When discussing the subject of race, several instances of the acclimation of plants were brought forward, and the list might be very greatly extended.

The effects of climate on man are limited therefore mainly to certain external characteristics which are not essential points in the determination of race. As Frédault* observes, the color of the skin is an accessory, not an essen-

* Traité de Anthropologie Physiologique et Philosophique. Paris, 1863, p. 75.

tial feature, and consequently does not suffice to distinguish races. In fact, color does not change the nature of the individual; and every one knows very well that a horse is always a horse, whether it be white or black; that a black dog is as much a dog as one that is white, and so on with many other examples that might be cited. In fact, zoologists are beginning to understand that they have exaggerated the importance of external markings in determining theories, and have too much neglected the peculiarities of organization and of internal structure.

2d. *The change from a warm or temperate to a cold climate.* It is much less frequently that we are called upon to lay down rules for observance in changing from a warm to a cold climate. The tide of emigration generally sets in an opposite direction, and, save for the guidance of those who are actuated by the spirit of adventure consequent on scientific research, it rarely ever happens that advice is asked for in regard to this variety of acclimation. But the subject is not the less important in its bearings on the hygiene of armies, which go where they are ordered, and which have frequently suffered by the neglect of proper sanitary measures when on service in cold climates.

The condition which follows on passing from a warm or temperate climate to a cold one is the reverse of that previously described as ensuing under opposite circumstances. Instead of being oppressed by the excessive action of the circulatory and respiratory organs, and bathed in the perspiration excreted by the skin, these functions are performed with much less vigor than the system requires, though the heart and lungs are taxed to their utmost to respond to the wants of the organism. The kidneys, on the other hand, have their function increased, at least so far as relates to the removal of water from the blood.

Now the effects upon the health which result from the change, though more gradually manifested than those pro-

duced by a hot climate, are not less certain or ultimately less strongly marked. The disease which proves most fatal to arctic explorers is scurvy, and this affection has mainly owed its ravages among them to a disregard on their part or an ignorance of the necessity for complying in all respects with the requirements exacted of them in consequence of the altered circumstances in which they were placed. To enter the arctic circle, or even a much lower degree of latitude, without changing the habits and mode of life, is as certainly productive of disease and death as is similar neglect under opposite relations in the torrid zone. Yet with proper precautions, and by taking an intelligent and physiological view of the surrounding conditions, it is as practicable to exist without disease within the arctic or antarctic circle, as midway between either and the equator, and far more so than within the tropics.

In considering this subject we shall take extreme latitudes as types of cold climate, premising that what applies to them is also applicable, though of course with less force and to less extent, to climates more moderate than those of the polar regions, but yet sufficiently removed from the equator and possessed of a low enough average temperature to entitle them to be classed as cold climates.

Food.—The original inhabitants of the frigid zones live entirely on animal food. They never have scurvy, and, as we have already said, are liable to but few diseases. The first explorers of polar regions failing to profit by the examples before them, ate salt meat and such vegetables as they were enabled to carry with them, and suffered severely from scurvy; many of their numbers perishing of this disease. Even the Russians of Siberia, according to Admiral Von Wrangel,* have neglected, after many years'

* Narrative of an Expedition to the Polar Sea, etc. London, 1844, p. 13.

observation, to pattern after the native tribes, and are consequently debilitated by disease and suffering. The Iakuts, one of the aboriginal tribes, live on sour cows' milk, mares' milk, beef, and horse flesh. They boil their meat, but never roast or bake it, and bread is unknown among them. Fat is their greatest delicacy. They eat it in every possible form—raw, melted, fresh, or spoiled. Farther north the inhabitants do not cook their food, and on this fact depends to a great extent their immunity from scurvy.

Dr. I. I. Hayes* states that the Esquimaux live upon an exclusively animal diet, their daily allowance of food being from twelve to fifteen pounds, about one-third of it being fat—the blubber mainly of the walrus, the seal, and the narwhal. In times of plenty they eat more than that quantity at a single meal, devouring as much as ten pounds of walrus flesh and blubber.

All arctic voyagers speak of this immense consumption of animal food to which the Esquimaux accustom themselves. Dr. Hayes further says:—

"It is in his generally large consumption of food that the Esquimaux hunter finds his shield against the cold; I do not believe that he could live upon a vegetable diet. Taste, with the pleasures which it brings, has very little to do with his meal; and he takes food through his capacious jaws with much the same passiveness as that of a locomotive upon receiving coal from the shovel of a fireman; and the cases are parallel. In the latter the carbonaceous coal is burned up in the furnace to make heat to make steam to start the wheels. In the former the carbonaceous blubber and flesh are burned up in the lungs to make heat to make steam to start the hunt. Feed the locomotive on willow twigs, and on a frosty morning it will

* An Arctic Boat Journey in the Autumn of 1854. London edition, p. 257.

be very likely to cease its operations; feed the Esquimaux hunter on wheat-bread or macaroni, and he will quickly freeze to death.

"The same laws govern the Esquimaux and the white men; and exposed as we were to temperature so low, living chiefly in an atmosphere varying from zero to the freezing point, and subjected during a part of the day to a temperature ranging from zero to sixty degrees below it, we found ourselves continually craving a strong animal diet, and especially fatty substances. The blubber of the walrus, the seal, and the narwhal was always grateful to us; and in its frozen condition it was far from unpleasant to the taste. I have frequently seen the members of our party drink the contents of our oil kettle with evident relish. * * * * * * * * *

"In view of this fact, I think I hazard nothing in saying that probably no climate in the world has less tendency to develop scurvy than that of the arctic regions, provided that the proper kind of food is used by the residents in it. This food must be chiefly animal, largely fat, abundant in quantity, and mainly free from salt. The Esquimaux are exempt from the disease, although they disregard all of our ordinary hygienic laws; and I am satisfied that with our present knowledge and experience scurvy need not be the formidable scourge which it was in former times, if indeed it need be known at all on board of vessels wintering in the arctic seas. Altogether the climate is one of remarkable healthfulness, for were it otherwise, living as we did in our close hut, we must have been attacked by disease."

In a paper read before the Biological Department of the Academy of Natural Sciences of Philadelphia, Dr. Hayes*

* Proceedings of the Academy of Natural Sciences, Biological Department, 1859, p. 9.

again discusses this question, and contributes a number of interesting facts to it. In regard to the scurvy, he again attributes its occurrence to the use of a salt-meat diet, and to cold, darkness, and excessive exertion, as accessories. It was owing to their weakened condition, resulting from the use of salt food, together with the influence of cold and darkness, that Dr. Kane's men were afflicted with an epilepto-tetanoidal disease, with which the dogs, from like causes, likewise suffered.

Alcohol, used habitually in large quantities, is doubtless injurious. Dr. Hayes regards it as prejudicial under any shape. On the other hand, tea and coffee are most useful. The English and Russians prefer tea; while Dr. Kane's men took most kindly to tea in the evening when retiring, and coffee in the morning when preparing for a day's journey.

In regard to cooking the animal food digested by arctic voyagers, it would appear, as the result of all experience, that it is more nutritious and a better anti-scorbutic when eaten raw. Dr. Hayes has frequently found that the stomachs of scorbutic patients which rejected the cooked meat, retained the raw. By freezing, the repulsiveness of raw meat is entirely destroyed. It is well known to physicians that raw meat is far better borne by the stomachs of children laboring under cholera infantum than meat which is cooked. In his recent voyage to the arctic regions, Dr. Hayes and his men lived entirely on fresh meat and tea and coffee, without the occurrence of a single case of scurvy among them.

On the other hand, take the instance of the Dutch sailors who, about the year 1636, spent a winter on Jan Mayen. Huts were built for them, and having been furnished with an ample supply of *salt provisions*, they were left, seven in number, to solve the problem as to whether or not human beings could support the severities of the climate. I quote

from Lord Dufferin* the story of their sufferings, mostly in the language of the last survivor of the devoted band.

"'The 26th of August our fleet set sail for Holland, with a strong northeast wind and a hollow sea, which continued all that night. The 28th, the wind the same; it began to snow very hard; we then shared half a pound of tobacco betwixt us, which was to be our allowance for a week. Towards evening we went about together to see whether we could discover anything worth our observation, but met with nothing.' And so on for many a weary day of sleet and storm.

"On the 8th of September they 'were frightened by the noise of something falling to the ground;' probably some volcanic disturbance. A month later it becomes so cold that their linen, after a moment's exposure to the air, becomes frozen like a board. Huge fleets of ice beleagured the island; the sun disappears; and they spend most of their time in 'rehearsing to one another the adventures which had befallen them by sea and land.' On the 12th of December they kill a bear, having already began to feel the effects of a salt diet. At last comes New Year's day, 1636. 'After having wished each other a happy new year, we went to prayers, to disburden our hearts before God.' On the 25th of February (the very day on which Wallenstein was murdered) the sun reappeared. By the 22d of March scurvy had already declared itself. 'For want of refreshments we began to be very heartless, and so afflicted that our legs are scarce able to bear us.' On the 3d of April, 'there being no more than two of us in health, we killed for them the only two pullets we had left; and they fed pretty heartily upon them, in hopes it might prove a means to recover their strength. We were sorry we had

* Letters from High Latitudes. Being some Account of a Voyage in the Schooner Yacht Foam to Iceland, Jan Mayen, and Spitzbergen, in 1856. London, 1857, p. 154.

not a dozen more for their sake.' On Easter day Adrian Carman, of Schiedam, their clerk, dies. 'The Lord have mercy upon his soul, and upon us all, we being very sick.' During the next few days they seem all to have got rapidly worse; one only is strong enough to move about. He has learnt writing from his comrades since coming to the island, and it is he who concludes the melancholy story. 'The 23d of April the wind blew from the same corner with small rain. We were by this time reduced to a very deplorable state, there being none of them all, except myself, that were able to help themselves, much less one another, so that the whole burden lay upon my shoulders, and I perform my duty as well as I am able as long as God pleases to give me strength. I am just now a-going to help our commander out of his cabin, at his request, because he imagined by this change to ease his pain, he then struggling with death.' For seven days this gallant fellow goes on 'striving to do his duty,' that is to say, making entries in the journal as to the state of the weather, that being the object their employers had in view when they left them on the island; but on the 30th of April his strength too gave way, and his failing hand could do no more than trace an incompleted sentence on the page.

"Meanwhile succor and reward are on their way toward the polar garrison. On the 4th of June up again above the horizon rise the sails of the Zealand fleet; but no glad faces come forth to greet the boats as they pull toward the shore; and when their comrades search for those they had hoped to find alive and well—lo! each lies dead in his own hut,—one with an open prayer book by his side; another with his hand stretched out towards the ointment he had used for his stiffened joints; and the last survivor with the unfinished journal still lying by his side."

From what has been said we can easily see how readily

man can adapt himself to the rigors of a polar winter; how he can preserve his health, both bodily and mental, by making his food conform in quality and quantity to the conditions so different from those to which he has been accustomed. And we also see how, when he attempts to carry into a different climate the habits of life peculiar to another, disease and death surely and speedily overtake him.

The general principles which we wish to bring prominently forward are these: that in cold climates the food should be mainly animal, that it should be fresh, and that it may properly be ingested in quantities which, if taken in warm climates, would certainly cause disordered functional action. It would be well therefore for the good of troops serving in cold regions that these points should engage the attention of those having the charge of this matter.

In regard to alcohol, the united testimony of arctic voyagers is decidedly against it. And yet there appears to be an instinct in the inhabitants of high latitudes to indulge in the use of it. Everest* cites the habits of the people of northern Norway as being very bad in this respect, and the same may be said of all northern nations who have among them the materials for the manufacture of intoxicating liquors, or who know how to obtain such beverages.

Exercise.—The necessity for exercise in cold climates is greater than in any other. The principal element that man has to contend against is the low temperature, and exercise, by increasing the extent of the chemical changes going on in the body, at the same time causes a greater development of heat. The advantages of exercise have been recognized by all arctic explorers as a powerful preventive of scurvy.

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* A Journey through Norway, Lapland, and part of Sweden, etc. London, 1829, p. 80.

Clothing.—The clothing should of course be adapted to the requirements of the climate. Reindeer skins are more generally used, and even the face requires to be protected from the intense cold which so commonly prevails.

CHAPTER XII.

HABITATIONS.

MEN construct habitations for shelter, for isolation, and for various special objects incident to a civilized condition. A building of any kind intended for mankind to live in, has necessarily connected with it some objectionable features. It incloses a certain amount of air which is shut off from the external atmosphere; it excludes a large proportion of the light which is so necessary for the well-being of the human organism; it brings its residents into closer contiguity than if they simply dwelt upon the soil, and hence allows of their becoming diseased through the emanations from their own bodies; it requires (in cold or temperate climates at least) to be heated, and this process, as it is ordinarily conducted, is another source of disease; it is illuminated at night, which gives rise to additional contamination of the air confined within the structure; and it must be furnished (in civilized countries) with drains, which are rarely constructed as they should be.

Now the object is to reduce all these causes of insalubrity to the lowest possible minimum consistent with the retention of the essential characteristics of a house. It would be easy enough to get rid of them all by living in the open air, but by so doing, other factors would be brought into action far more injurious in their operation

than those we have cited. The house is the great essential of civilization: without it man would be a savage again. It is infinitely better therefore that we should tolerate the concomitants mentioned, or, what is still preferable, seek, by the study of their relations and the laws by which they are governed, to lessen, even if we cannot entirely prevent, the injurious effects which result from their operation.

Leaving out of special view the consideration of the hygiene of structures intended for certain particular purposes, such as theaters, manufactories, and public buildings of various kinds, and which properly belong to the domain of public hygiene, we shall confine ourselves to the sanitary principles which should govern in the situation, construction, and hygienic management of hospitals, barracks, and encampments, though it will be found that the views enunciated are applicable, with greater or less force, as the case may be, to buildings of all kinds.

CHAPTER XIII.

HOSPITALS.

It is especially necessary that the utmost care should be taken to secure every hygienic advantage in the location and construction of hospitals. Unlike other habitations—with the exception of prisons—the inmates are incapable of going out to obtain fresh air and light. They must submit to the conditions in which they are placed, and if these are such as are inconsistent with the requirements of sanitary science, the evil falls upon them with much greater force than upon those able-bodied persons who, though

they may reside in insalubrious habitations, are within their walls but a small portion of the day.

Moreover, in hospitals numbers of sick persons—sometimes several hundred or even thousand—are brought together, affected with every imaginable disease or injury, and oftentimes with their bodies and clothing contaminated with the excretions and other filth which have accumulated or been absorbed through their neglect of the simplest habits of cleanliness, and thus influences are at work tending still further to add to the pathological conditions in which the inmates are placed.

So far as hygiene is concerned, no difference exists in the requirements for civil and military hospitals; both classes are subject to the same general sanitary laws, and the inmates of both are entitled to equal consideration from those who are placed in charge of them. But it will, on many accounts, be more to the purpose to refer more particularly to military hospitals in the remarks to be made under this head, though I shall not hesitate to bring forward such examples of excellent civil hospitals as may tend to illustrate any point under discussion.

LOCATION.—Great pains should be taken to insure healthy locations for hospitals, and also to secure advantages in other respects, such as seclusion from noise and bustle, facility for the supply of water and gas, accessibility, etc. If these latter points can be provided for, hospitals are better situated out of town than in the midst of crowded portions of large cities, which are always more unhealthy than the country.

The neighborhood of manufactories, from which noxious vapors are evolved, or of places in which decomposition of animal or vegetable matter is going on, such as slaughter-houses, tanneries, manure factories, market-houses, graveyards, etc., should be scrupulously avoided. During the war in the Spanish Peninsula the sick in the hospitals at

Ciudad Rodrigo were affected with dysentery, hospital gangrene, and tetanus, to an extraordinary degree, consequent, as it appeared, upon the burial of over twenty thousand bodies within the limits of the city during the few months immediately preceding its occupation as a hospital station.

The vicinity of rivers, canals, ponds, marshes, the mouths of sewers, and other places of the kind, which ordinarily give rise to malarious emanations, or those due to the decomposition of organic matter, should likewise be shunned.

The ground should be elevated in order to secure good drainage, and also because experience has fully shown that high situations, other things being equal, are far more salubrious than those which are low. This circumstance is due to facts which have already received attention, and which now admit of application. Elevated points allow of a freer circulation of air around them, and thus stagnation is prevented. They are also less exposed to dampness and malarious influences. Instances, however, are not wanting in which this consideration has been overlooked. Thus we are told* that the hospital of the Guards' recruiting barrack at Croydon is in a low, damp situation, and was till recently exposed to nuisance from a sewage manure manufactory, pig-sties, etc., and cases of simple fever received into it were found to pass into typhus, or to linger for months after, to all appearance, they ought to have recovered. The hospital at Fort Meade in Florida was situated in the worst possible position, being in a low, marshy place, exposed to highly concentrated malaria, and shut off, by a heavy growth of timber, from the rays of the sun. It was not till its unhealthiness had been thoroughly ascertained that it was removed. The Hôtel-Dieu, in Paris, which is situated on both banks of the Seine, is un-

* Report of Commission on Barracks and Hospitals, p. 120.

favorably located, as during high water the premises are overflowed, and an excessive degree of humidity thereby produced. Many other examples might be brought forward; for, contrary to what should be the case, sites for hospitals are often selected by persons who have no knowledge whatever of the first principles of hygiene.

The soil upon which a hospital is to be built should be of such a character as will not retain moisture; a sub-soil of clay, for the reasons which have been given, is objectionable. One of gravel answers all the indications. The new hospital at Fort Mackinac is built upon the solid rock, and is consequently not liable to accumulations of water about it. Too much care cannot be taken to examine into the character of the soil and sub-soil, for if a site is chosen regardless of the points laid down, disease—either fevers, bowel affections, rheumatism, or catarrh—will inevitably be produced.

The first floor of a hospital should not be placed directly on the ground. A basement should be under it, or pillars should be built, raising it three or four feet above the surface. Cellars should not be dug, unless the site is dry and well drained, as they are otherwise apt to be damp, and consequently sources of unhealthiness. The long axis of the building should run north and south, in order that both sides of it may have the sun on them a part of the day.

In military hospitals it is sometimes impossible to comply with all the necessary hygienic conditions, especially in those which are attached to permanent fortifications or barracks. In sea-coast works is this especially the case, the only available hospital accommodation being the casemates. These are notoriously damp, badly ventilated, and unhealthy. At Fortress Monroe, however, and several others of the largest fortifications, hospitals have been constructed apart from the work within the walls, which, though by no means hygienically perfect, are yet far preferable to those in casemates.

With the general hospitals the case is, however, different, as full liberty is allowed the officers of the medical department in the selection of the sites for them. We shall have occasion, in considering particular hospitals, to allude more particularly to the advantages and disadvantages of their location.

MATERIAL FOR CONSTRUCTION.—For permanent hospitals stone is preferable to any other material for the walls. It should be hard and dense, so as to be incapable of absorbing moisture to any extent. Porous stone and brick are objectionable on account of the facility with which they absorb water from the atmosphere. If they are used, the walls should be double, so as to allow of a stratum of air between them. The experiments of Roscoe,* however, would appear to show that brick walls allow of the escape through them of a considerable amount of the carbonic acid formed within habitations.

For lining the walls Parian cement is to be preferred, though, on account of its expense, it is often impossible to provide it. Hard-finished plaster is the best substitute, but it should be well painted and varnished, to prevent the absorption of exhalations.

The floors of the wards and offices should be of oak, saturated with a mixture of beeswax, turpentine, and linseed oil, in order to prevent its absorbing water used in cleaning, or liquids which may be accidentally spilt.

The floors of the halls and staircases should be of stone or encaustic tiles.

Temporary hospitals are better constructed of wood than of other material. When it is practicable, they should be plastered inside and out and well whitewashed. The floors should be coated with some water-proof material,

* Quarterly Journal of the Chemical Society of London, vol x. 1858, p. 251.

such as that before mentioned. They are far healthier than permanent buildings, an assertion the truth of which has been thoroughly demonstrated during the present rebellion. For wounded men tents, both in winter and summer, are the best of all hospitals.

FORM AND GENERAL ARRANGEMENT.—In order to elucidate all the points connected with the form and general arrangement of hospitals, it will be proper to adduce examples of bad plans as well as of those which are based upon an acquaintance with sanitary laws. In constructing and administering a hospital, certain principles are to be observed.

1st. That it is capable of being well ventilated.

2d. That it is sufficiently capacious for the number of inmates it is to contain.

3d. That it admits of good drainage.

4th. That it is provided with a sufficient number of windows.

5th. That the kitchen, laundry, and other offices of administration are well arranged and of ample size.

6th. That efficient water-closet, ablution, and bathing accommodations are provided.

7th. That it is amply supplied with water, and gas or other means of illumination.

8th. That the furniture, of all kinds, is of suitable quality.

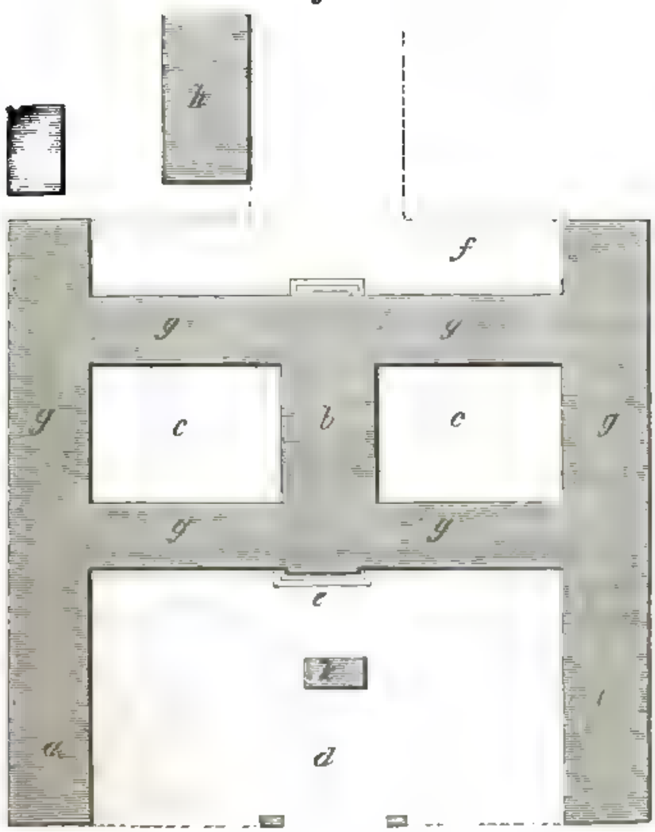
9th. That the officers and attendants have their proper respective duties assigned to them, and that they are in number sufficient for the wants of the sick.

10th. That proper rules are established for the government of the hospital, for the diet of the inmates, and for preserving order and an efficient state of police.

Some of these points will be considered in the course of the remarks relative to the principles of hospital construction and to particular hospitals, while others will be more appropriately discussed under their own separate heads.

One of the oldest plans adopted for hospitals, as it is certainly one of the most objectionable, is that in which three or four sides of a square are built upon. The disadvantages of it are that both light and air are excluded to a considerable extent. An example of it is shown in the accompanying cut, (Fig. 16,) representing the ground-plan

Fig. 16.



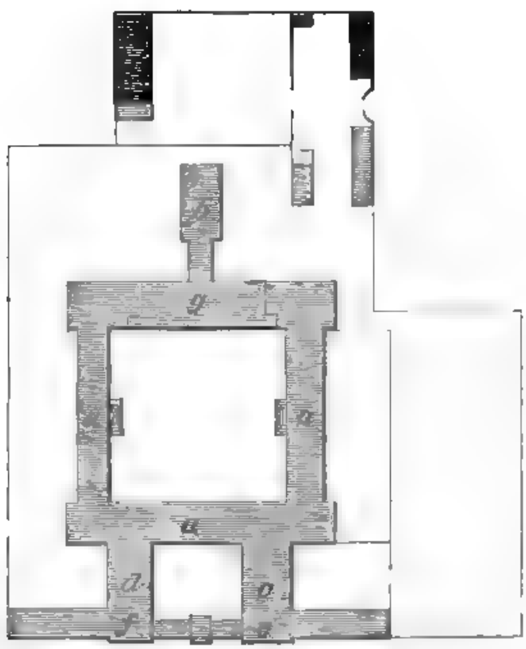
GROUND-PLAN OF GUY'S HOSPITAL, LONDON.

of Guy's Hospital, London: *a*, administration; *b*, corridor; *c*, court-yard; *d*, principal court-yard; *e*, entrance; *f*, walks; *g*, wards; *h*, ophthalmic ward; *i*, offices, kitchen, etc.

It needs no argument to point out the faults in the con-

struction of this hospital. The two closed courts effectually prevent the free circulation of the air, and shut out a large portion of the light which the patients so imperatively require.

Fig. 17.



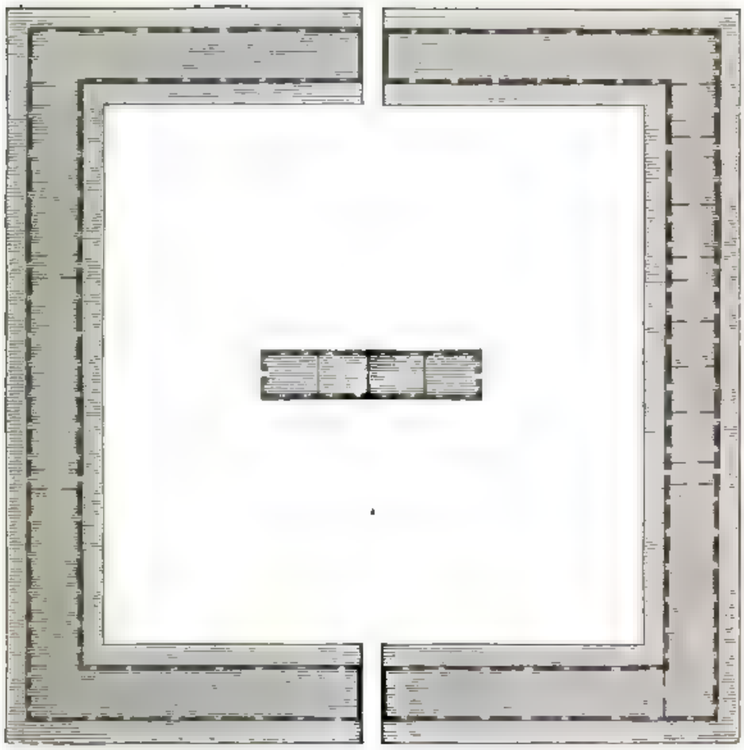
GROUND-PLAN OF THE HÔPITAL NECKER, PARIS.

The Necker (Fig. 17) in Paris is equally bad in its plan, three sides of a square being entirely shut in by wards, and the fourth partially closed by a gallery: *a*, wards; *b*, chapel; *c*, kitchen; *d*, pharmacy; *e*, offices; *f*, officers' rooms; *g*, gallery.

The plan under consideration has been entirely abandoned for hospitals by all having the slightest acquaintance with the principles which should govern in the construction of habitations for the sick. It is unfortunate, therefore, that at Hilton Head, South Carolina, a hospital

should have been built, during the first year of the rebellion, combining all the bad features which belong to the two last described. Fig. 18 represents the arrangement. It

Fig. 18.



GENERAL HOSPITAL, HILTON HEAD, SOUTH CAROLINA.
SCALE $\frac{1}{1000}$.

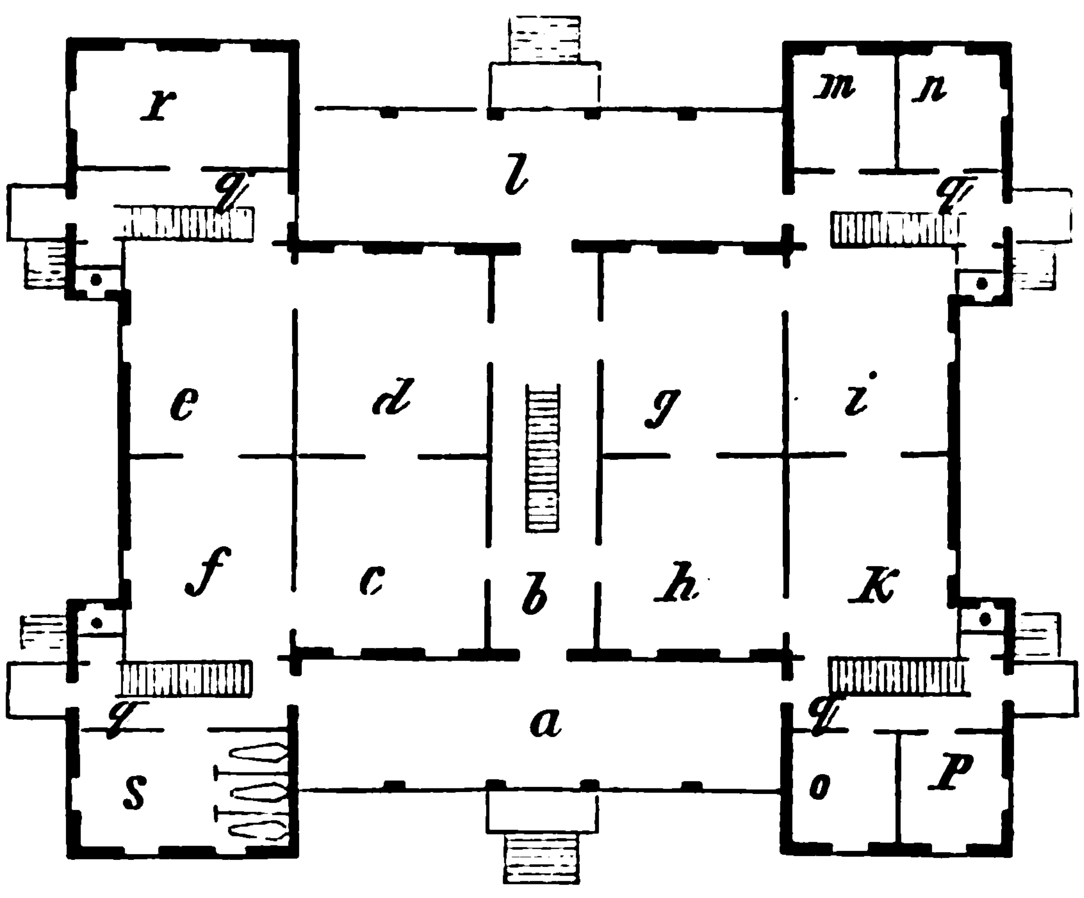
is essentially a closed court, for the attempt made to open the sides can lead to very little practical advantage. In warm climates it is far more essential than in cold or temperate regions that a free circulation of air should be provided for, and hence the objectionable arrangement of the hospital at Hilton Head should receive still greater condemnation than if it had been built in a northern locality. It is the only really badly planned hospital which has been

built for the army, though many structures, falling far short of the requirements of sanitary science, have necessarily been temporarily occupied by the sick and wounded.

The Bicêtre, the Salpetrière, the Saint Louis, and Maison Municipale de Santé of Paris, and the Ospitale Maggiore di Milano, are all built upon the general principle of the closed court or hollow square. The military hospital at Algiers is designed after the same bad model. With the exception of the last, these are all old structures.

Another plan, scarcely much better than the closed court, is that in which the wards are crowded together in pairs or by fours. The United States marine hospitals, of the first class, are all constructed upon this model, which really does not deserve to be considered as one at all fit for a hospital. The accompanying cut (Fig. 19) repre-

Fig. 19.

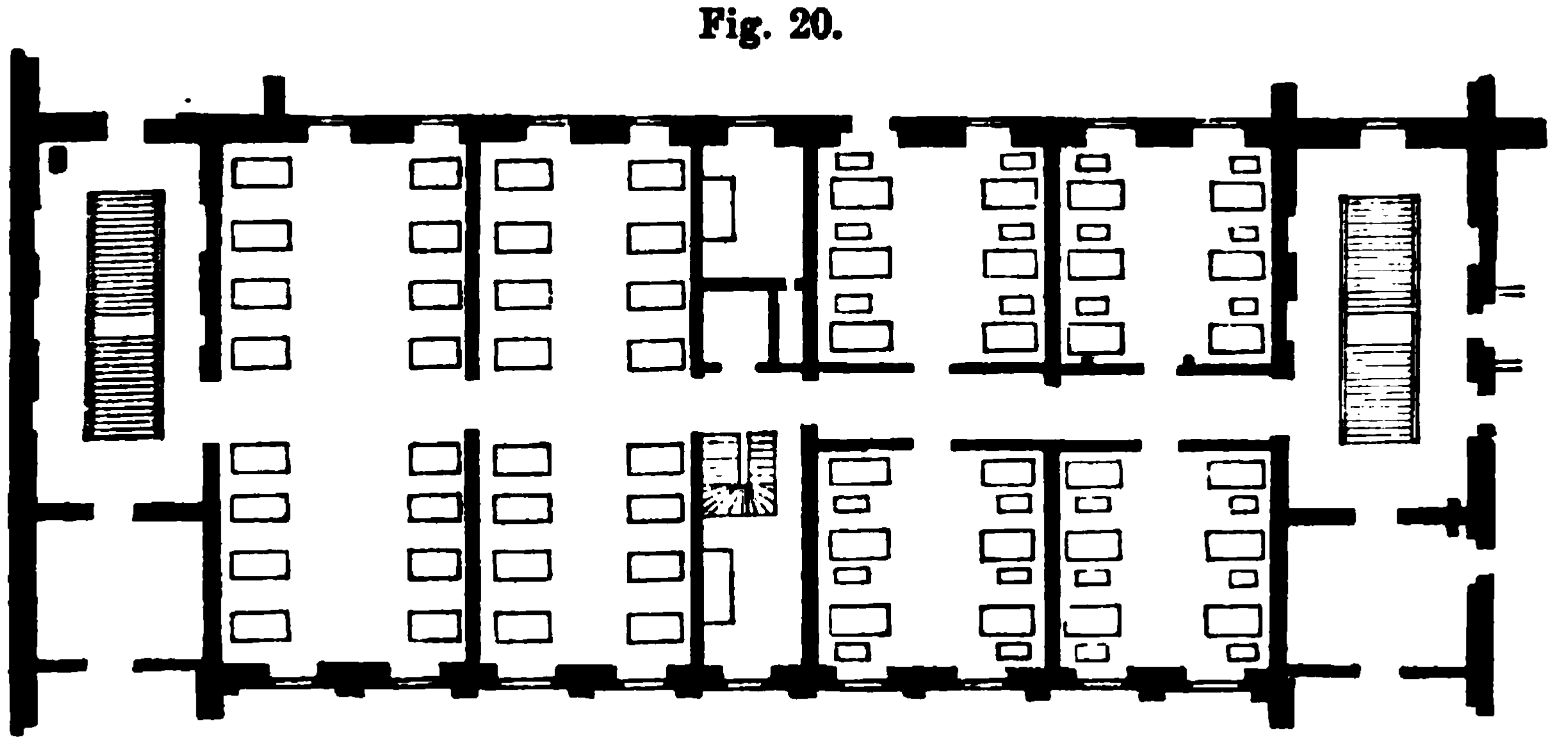


MARINE HOSPITAL, ST. LOUIS. (FIRST FLOOR.)

sents the ground-plan of the first floor of the marine hospital at St. Louis. The main wards are indicated by the letters from *c* to *k*. The principal object which the architect appears to have had in view was to prevent more than one exposure of each ward to the fresh air, doubtless sup-

posing that the sailors and boatmen to be admitted would have had enough of that element before their arrival. In this undertaking he has met with eminent success, and by the adoption of the happy idea which suggested itself to him of putting the square towers at the angles, he has reduced the number of windows in four of the wards on each floor to one. The others have two each. These wards are twenty feet square, and are each designed for eight patients. Each man has therefore but fifty square feet of surface, and, as the wards are not over twelve feet in height, he has only six hundred cubic feet of space. The letters from *m* to *p* indicate small wards, intended for two or three patients. The other rooms are offices. The letters *a* and *l* refer to the porches. These buildings are designed for one hundred and fifty patients each, are all three stories in height, and the floors are all arranged upon the same plan, which is a thoroughly vicious one.

Fig. 20.



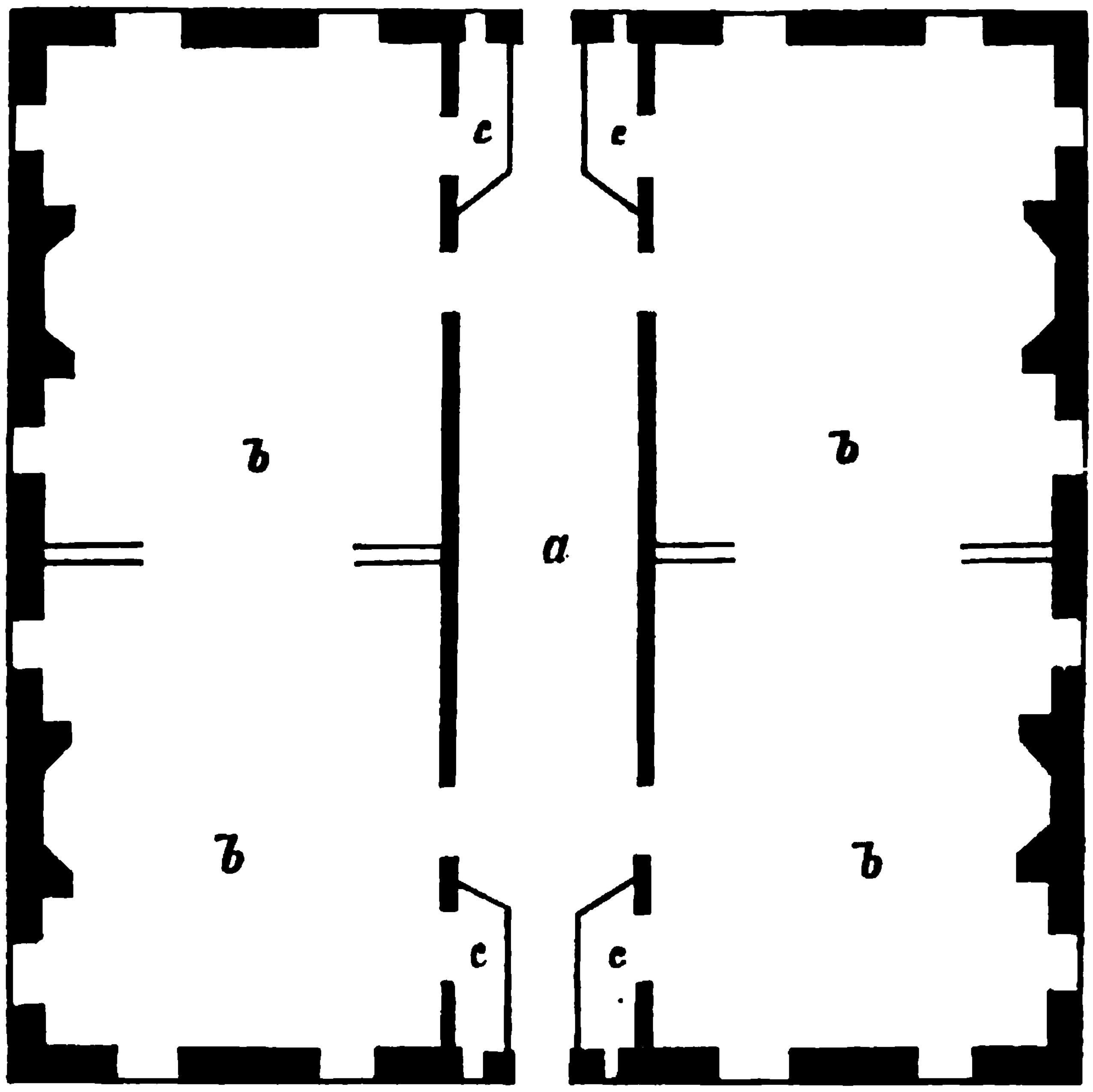
GROUND-PLAN OF THE HÔPITAL DE LA CLINIQUE, PARIS.

The Hôpital de la Clinique of Paris, (Fig. 20,) which was originally a monastery, is built upon the same general plan as the marine hospitals just described.

Most of the old post hospitals of the army are constructed after a similar model, though they are so arranged that two sides of each ward are exposed to the external

air. A plan of the principal floor is shown in Fig. 21: *a*, hall; *b b*, wards; *c c*, water-closets. A veranda surrounds

Fig. 21.

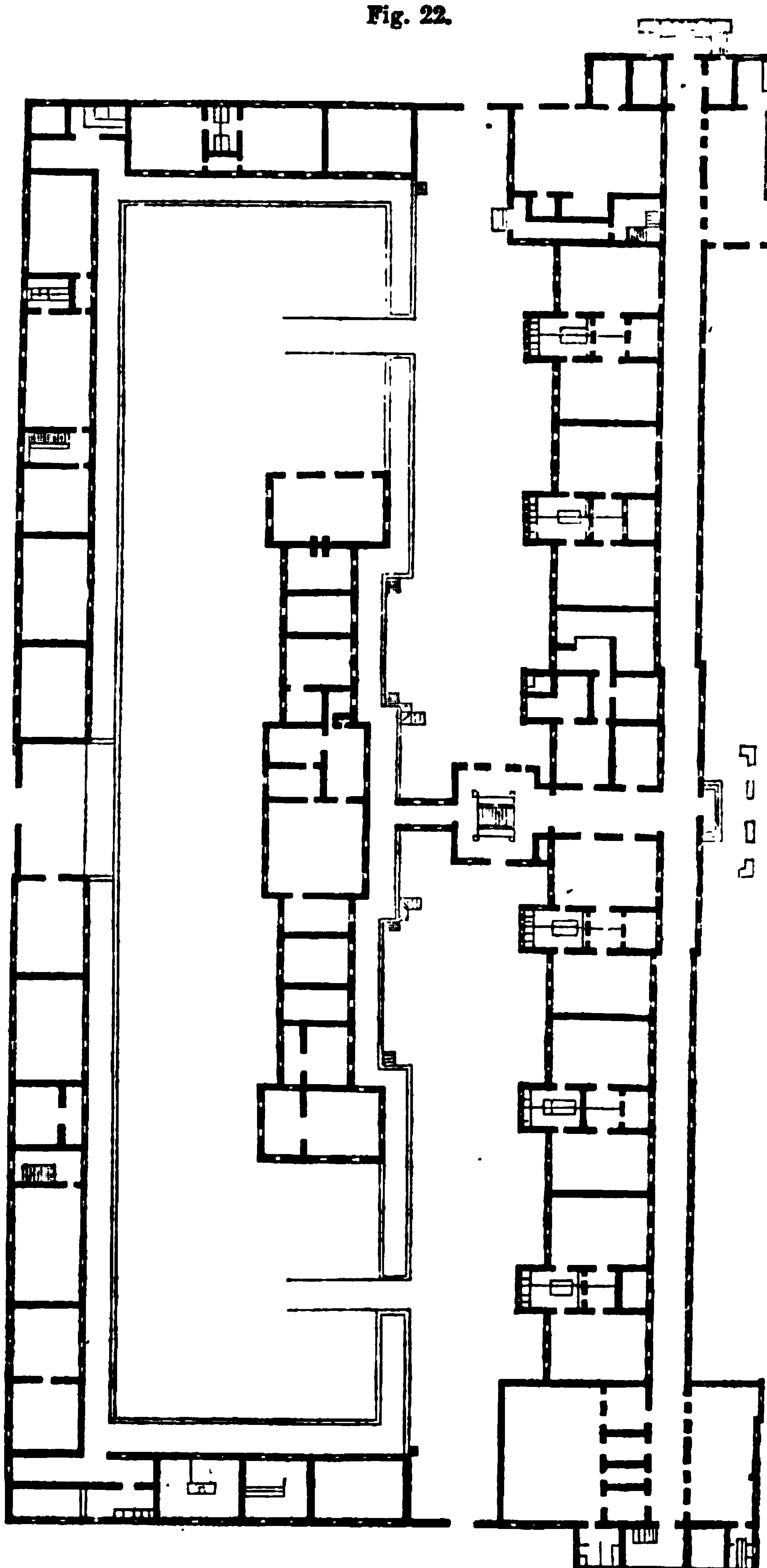


UNITED STATES ARMY POST HOSPITAL.
SCALE $\frac{1}{192}$.

the building. The chief objections to these hospitals are, deficient ventilation and want of capacity. They do not admit of more than five hundred cubic feet of space being allowed to each patient when the ordinary proportion of the men composing the garrison is sick.

In 1860 new plans were adopted for the construction of quarters, barracks, and hospitals, which, though improvements on the old ones, are not, so far at least as the hospitals are concerned, such as sound sanitary science would dictate. It is not probable that they will be carried out, and therefore it is scarcely worth while to discuss them.

Fig. 22.



VICTORIA HOSPITAL, NETLEY.

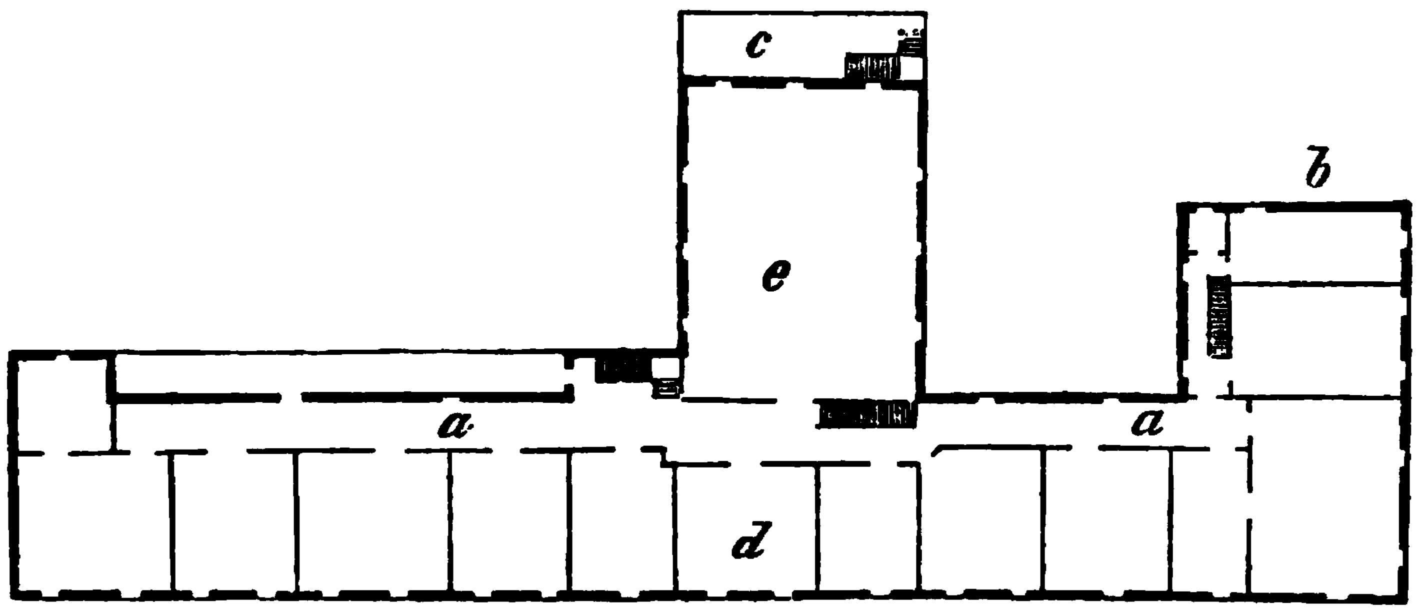
Another objectionable plan, and one which has been extensively used, more or less modified, according to the whim or caprice of the designers, is that in which the wards are arranged on one or both sides of a close corridor. The hospitals at Rotterdam, Hamburg, and Bremen are built after this plan. The wards are small and badly ventilated.

The new military hospital at Netley is also constructed after this principle. It was built by the engineer corps of the British army without, as I understand, the advice of the medical department being asked in the matter. As it is the most extensive military hospital in Great Britain, and has cost a large sum of money, it is unfortunate that a better design was not selected. The wards are of small size, containing each from nine to fourteen beds, and generally have but one face exposed to the external air. The ventilation and lighting are not therefore such as they should be, and from the small size of the wards it is difficult and expensive of administration. Fig. 22 is a representation of the ground-plan of the main floor of this hospital.

Several of the civil hospitals of this country are built according to the plan last referred to. None of the military hospitals which have been constructed during the present rebellion have, however, been thus arranged, though it has been found necessary to occupy buildings for hospital purposes the rooms of which are placed on one or both sides of a passage way. The Seminary Hospital in Georgetown (Fig. 23) is one of this kind. Originally constructed for a school, it was found necessary to occupy it as a military hospital. A closed corridor *a* runs nearly the whole length of the building, and the wards *d* are placed on one side of it. The opposite end of these wards faces the street. One large ward *e* is better situated; *b* is a bath-room, and *c* a veranda. The first and third floors

are similarly arranged. The basement contains the kitchen and other offices.

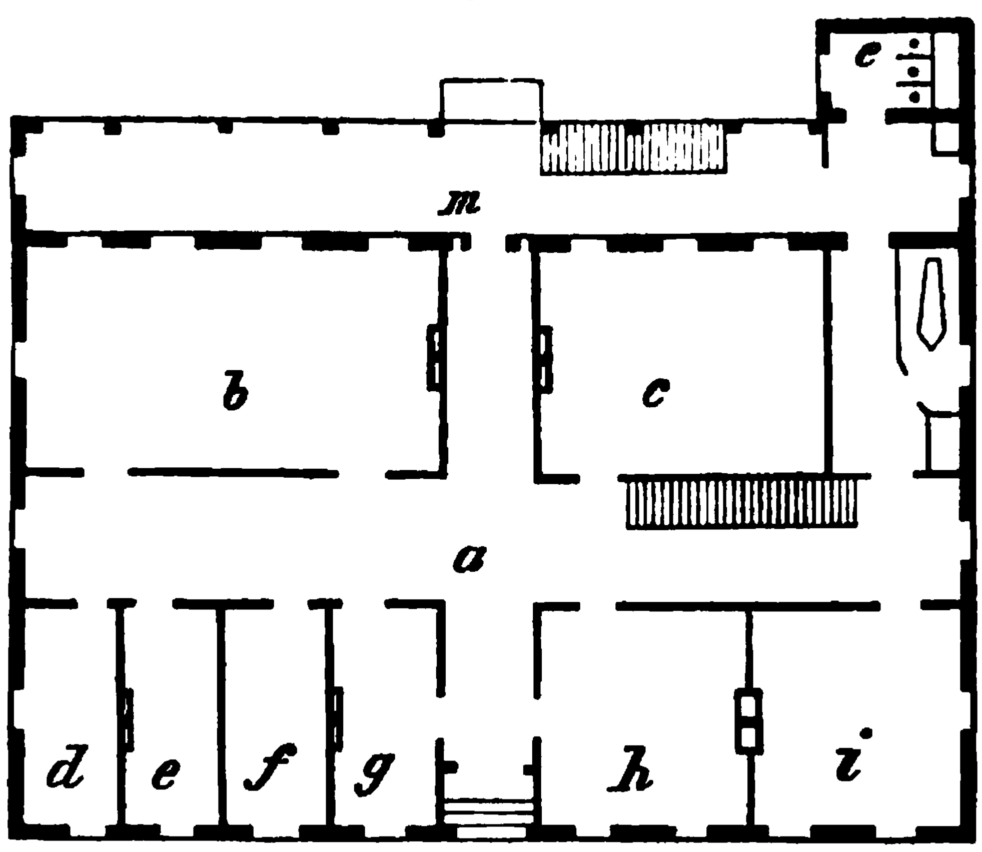
Fig. 22.



SECOND FLOOR SEMINARY HOSPITAL, GEORGETOWN.

The whole plan of this building is such as renders it not a very desirable one for use as a hospital. It had at one time over three hundred beds, but since it has been occupied as an officers' hospital the number has been materially reduced.

Fig. 24.



SECOND FLOOR GOOD SAMARITAN HOSPITAL, ST. LOUIS.

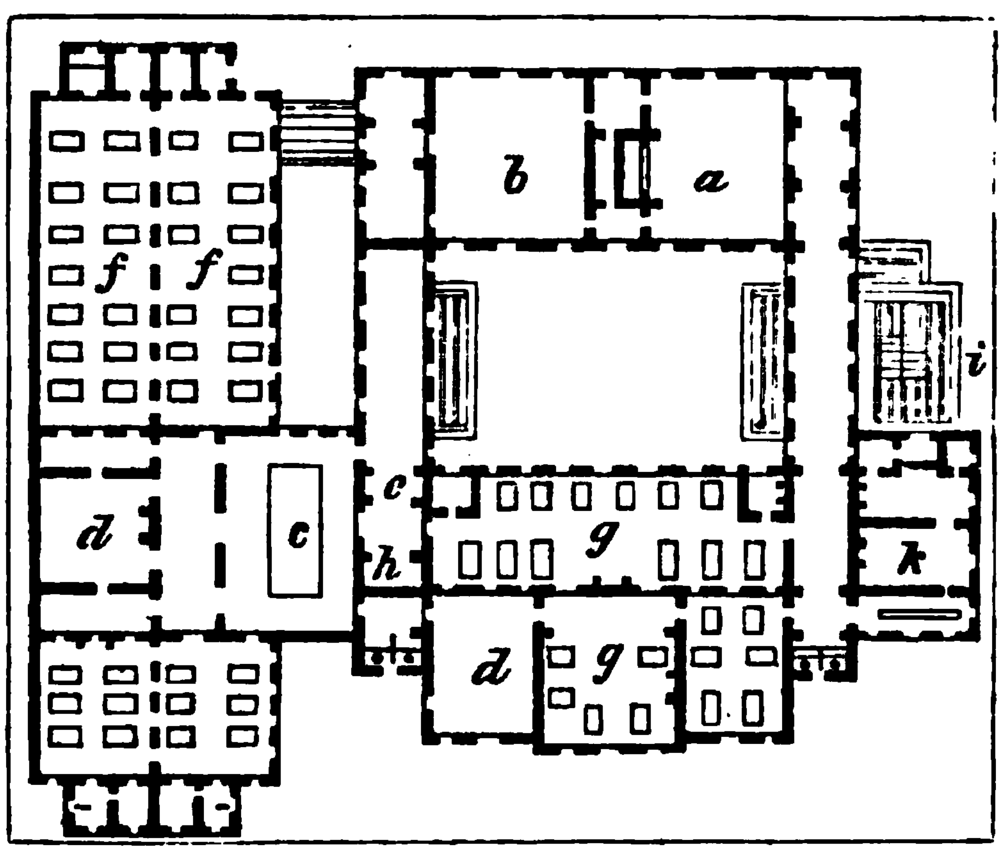
The Good Samaritan Hospital in St. Louis is another example of this form of construction. The cut (Fig. 24) represents a plan of the second floor. In this institution

the wards *c* to *i* are arranged on both sides of a corridor *a*; *k* indicates the bath-room, *l* the water-closet, and *m* a veranda. Two other floors are similarly planned. In addition, there is an attic, with a somewhat different but no better arrangement.

There are many other instances of bad hospital plans which do not come under any specific heading, but which are sufficiently objectionable to warrant attention, in order that their defects may be pointed out and avoided.

In the new hospital of King's College, London, the wards are double, an arrangement which is objectionable on account of the difficulty of isolating any patient from the effluvia given off by the others. The accompanying cut (Fig. 25) is a plan of this hospital: *a*, the chapel; *b*, the

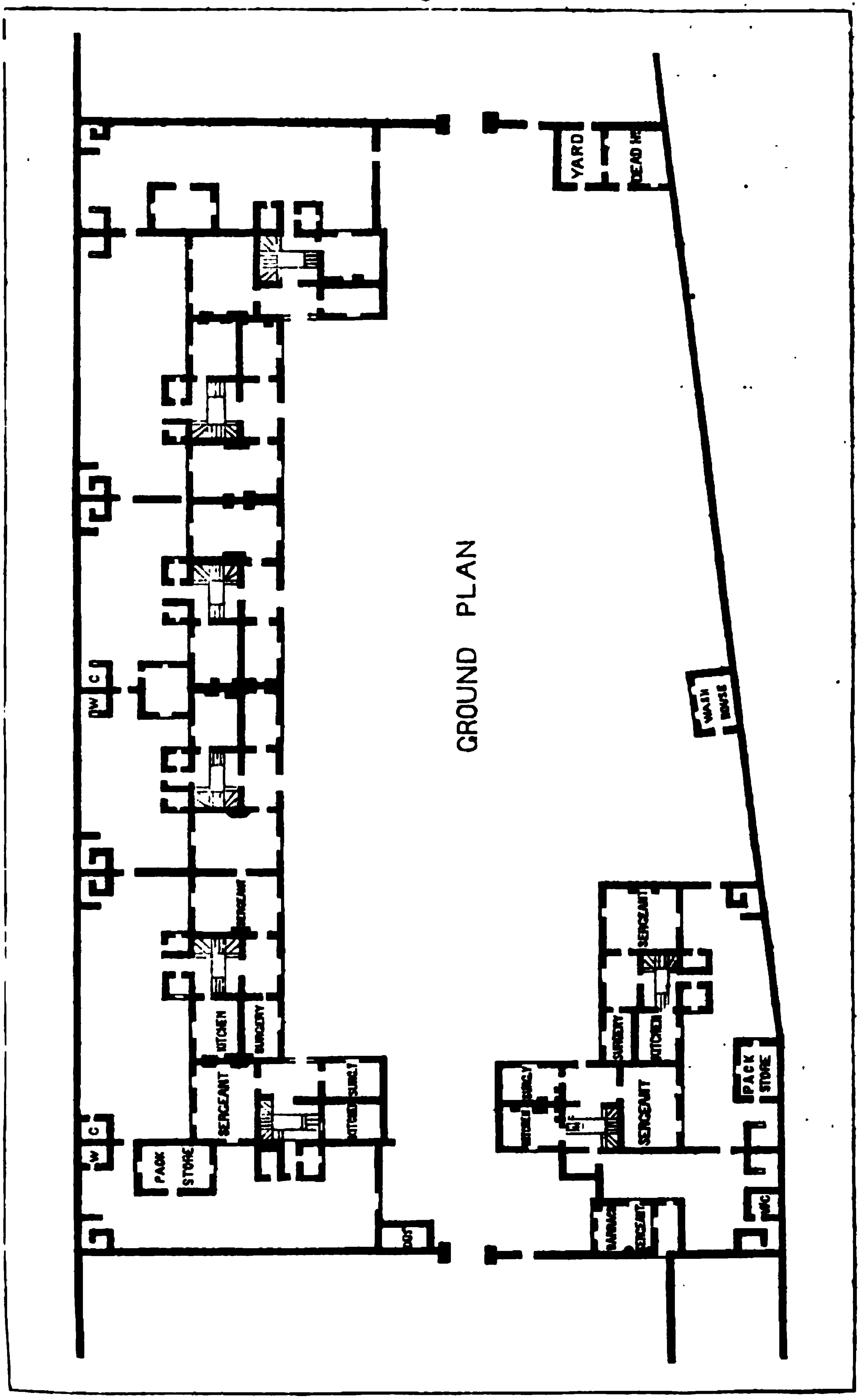
Fig. 25.



GROUND-PLAN OF KING'S COLLEGE HOSPITAL, LONDON.

amphitheater; *c*, wards; *d*, reception rooms; *e*, office. It is thus seen that in the principal rooms intended for the reception of the sick there are four rows of beds between the windows, and consequently the exhalations from three of the rows of beds pass over the other row before they can escape from the ward by the windows. The whole plan is

Fig. 26.



GROUND-PLAN OF ARBOUR HILL MILITARY HOSPITAL.

also most bunglingly conceived. The windows are on one side only of the wards, and the corridors, chapel, and amphitheater are so placed as effectually to close the courts, and thus some of the wards are entirely shut off from a free circulation of air about them. It would be difficult to meet with a worse constructed hospital in any country than that of King's College. The new wards of Guy's Hospital are arranged upon the same general plan as those just described.

Hospital wards should never contain more than two rows of beds. In military hospitals, from the sudden necessities of the service, large numbers of sick and wounded are thrown upon the hospitals, and of course must be provided for. It then occasionally becomes necessary to put an additional row of beds along the center of the wards, but they should be removed as soon as possible, no matter what may be the width of the room.

The military hospital at Arbour Hill, Ireland, exhibits another peculiarly bad style of arrangement. As is seen from the cut (Fig. 26) it is divided into four sections, each of which is complete in itself, having its own ward, surgery, kitchen, store-room, etc. Aside from the expense and inconvenience of such a plan, it takes up room for unessential objects, which might have been devoted to the reception of patients. I do not know that there is a hospital in the United States constructed on such an absurd principle as is the one at Arbour Hill. It is very properly condemned by the commission which examined it and the other military hospitals of Great Britain and Ireland.*

Another faulty plan is that in which several stories are built, one over the other. It may be laid down as a rule that hospitals should never consist of more than two floors of wards; one is preferable, owing to the great difficulty of

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* Report, p. 128.

administration more than counterbalancing any advantages that may be derived from the other arrangement. It is true, as we have seen, that the upper rooms in buildings are more healthy than the lower, but the advantages of elevation can be secured by a high basement range, which should be constructed for storage and other purposes of the kind.

This plan of three or more floors is a very common one in hospitals in cities where ground is scarce, especially in those which were built several years since; but even the new hospitals Lariboisière and the military one at Vincennes have three tiers of wards, a very decidedly objectionable feature in their otherwise generally excellent arrangement. The City and Bellevue Hospitals of New York have also three stories of wards.

But, in addition to the difficulty of administration, there is another objection of even still greater weight. The crowding together of so many wards under one roof has the same effect as placing too many sick in one room. It has been definitely determined that not more than one hundred sick can be kept under one roof without an increased mortality being the result. And it does not make a great deal of difference whether they are contained in one sufficiently large room or in several smaller ones.

Other objectionable principles of hospital construction will be pointed out in the descriptions of those hospitals which are built upon generally good plans, but which possess some features in their arrangements which do not admit of commendation.

CHAPTER XIV.

PRINCIPLES OF HOSPITAL CONSTRUCTION.

In setting out to build a hospital, the first object to be had in view is the provision of ward accommodation; the next the provision of accessories, such as kitchens, water-closets, bath-rooms, offices, etc. We shall therefore first consider the best form for the ward, and the several appointments which should be given to it.

Wards.—A hospital ward should be of an oblong shape, the form which is best adapted for the arrangement of beds, and supplying the patients with sufficient light and fresh air without wasting space. The width should not exceed twenty-five feet, a space which will allow seven feet six inches for the length of each bed, with a passage of ten feet between the rows. If the width is greater than this, the distance between the windows is such as to prevent free ventilation; if less, sufficient room is not afforded.

In permanent hospitals the height should not be less than fourteen feet, nor over sixteen. Less than this renders the air close, while more is of little or no advantage. In temporary hospitals, such as those often required in the army during war, which are not ceiled, and which are ventilated at the ridge, twelve feet to the eaves will be found to answer if the roof is high pitched—the only kind which should be constructed, as flat roofs are more liable to leakage, and render a ward hotter in summer than those that are steep.

The length of the ward depends upon the number of beds it is to contain. The bed should be about three feet

in width, and the average distance between should be four feet. As they are arranged in pairs between the windows, the two beds of any one pair are not so far from each other as this; but compensation should be made by increasing the distance between the pairs, so that it may average about four feet. Each bed therefore occupies a space in the length of the ward of seven feet, consequently a ward intended for fifty beds—twenty-five on a side—would be $25 \times 7 = 175$ feet, the length of the ward. A ward therefore of these dimensions ($25 \times 175 \times 14$) contains 60,250 cubic feet, or 1205 cubic feet to each of the fifty patients.

These dimensions are the very lowest which should exist in the wards of permanent hospitals in any part of the United States. Every patient in such institutions should receive, as a *minimum allowance*, 1200 cubic feet of space, about 87 of which should be superficial. If less than this is allotted to him, an offense is committed against the laws of human health, which can only be excused on the ground of absolute necessity.

In temporary hospitals, ventilated at the ridge and furnished with a sufficient number of windows, less than this will suffice, provided they are built after the plans which have been shown to be most advantageous to the sick and wounded who are to inhabit them; and consequently in such wards the length need not be so great as in those of permanently built hospitals. In these ridge ventilated wards, of the same width as the others and the same average height, the mean distance between the beds need not be more than two and a half feet; $25 \times 5\frac{1}{2} = 137\frac{1}{2}$ feet, the length of a ward intended for fifty patients. Such a sized ward contains 48,125 cubic feet, which is about 960 to each patient.

This is the basis upon which all temporary hospitals should be constructed, and although, from the necessities

of the service, it may often be impossible to give to each inmate as much space as the requirements of sanitary science demand, he should receive it without fail as soon as the exigency, which has caused a reduction in his allowance of space, has ceased to exist.

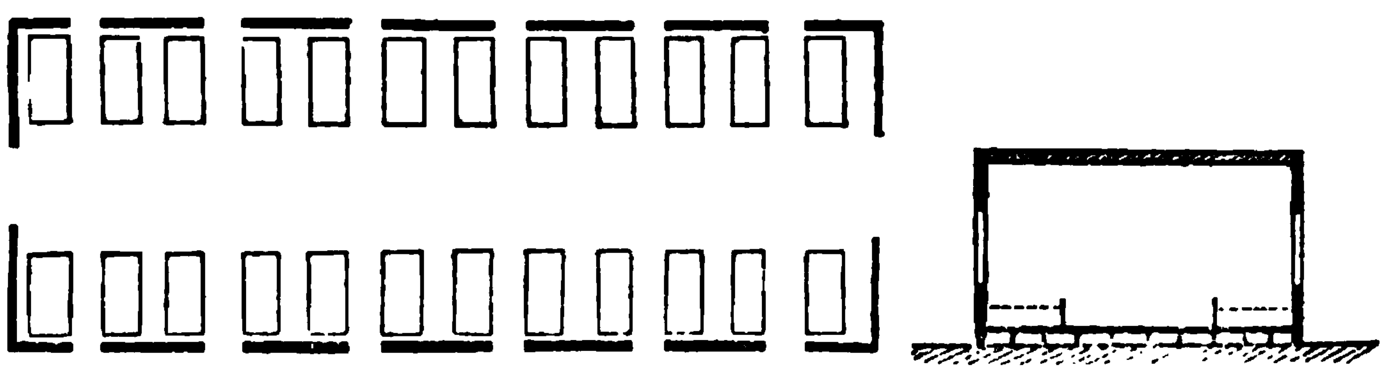
The width of twenty-five feet has been given as a standard. The bedsteads should be six feet three inches in length, and should stand nine inches from the wall. This gives seven feet for the length of the bed and fourteen for the two rows, leaving therefore a passage down the center of the ward of eleven feet in width. This space is necessary not only as a hygienic measure, but as room required for tables, chairs, and other ward furniture. The width of the ward is therefore invariable, and is the basis from which the other measurements are to be determined.

As has been said, the mean height of a ward should not be less than fourteen feet, and it is upon this, as a standard, that the cubic space per patient is to be apportioned. It will not answer to make the wards high and to curtail them proportionally in the other dimensions, for after the height of fourteen or fifteen feet is attained in a ward the air of any space above that is of very little practical benefit to the patient. It is by no means impossible to produce sickness in well persons by crowding them together in the open air, where the number of cubic feet of air to each is only limited by the height of the atmosphere above the surface of the earth. The number of square feet to a patient, in a ward fourteen feet high, should not, in permanent hospitals, be less than eighty-five, nor in temporary, ridge ventilated wards, less than sixty-five feet.

The windows in a ward should be of ample size, certainly not less than five feet in height. The number should be determined by the size and capacity of the ward, one being allowed for every two patients. They should be placed in the long sides of the ward.

Two beds should be placed between every two windows, the heads standing toward the walls, but distant about nine inches from them. The arrangement of the beds and windows, as well as the proportions of the ward, are shown in the accompanying cut, (Fig. 27,) in horizontal and vertical sections. The plans represent a ward for twenty-six beds. Wards of double the length are usually those which are found in the new military hospitals built since the commencement of the present rebellion. Such wards contain fifty-two beds, a number which should not be exceeded.

Fig. 27.



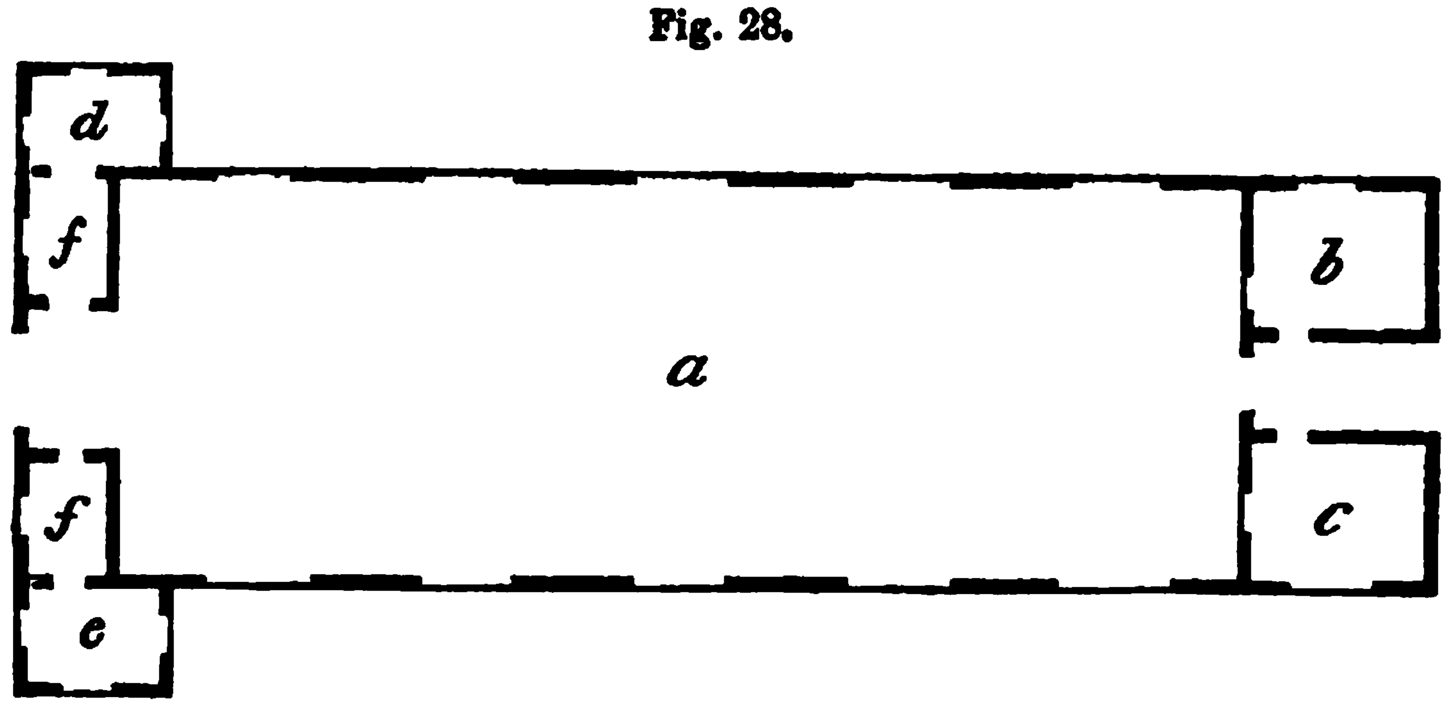
Now in addition to the ward, and constituting almost a part of it, as they are connected with it directly, are certain rooms which are indispensable. These are a bath and ablution room, a water-closet, and a ward-master's room. Besides, a mess-room is often added, in which those patients who are able to leave their beds eat their meals, and in which a sink is placed for the convenience of washing dishes. When the mess-room is not attached to the ward, a scullery takes its place. Occasionally a small extra diet kitchen is one of the offices.

The ward-master's room is a very necessary appendage, and generally has a window opening from it into the ward, in order to allow a proper supervision to be exercised over the inmates by the ward-master. The bath and ablution room and water-closet are at the same end, the latter being farthest from the ward. In all military hospitals, so situated that water can be supplied from a main, an abundant supply is thus obtained, both hot and cold.

One bath-tub will be found sufficient for every twenty-six patients; one basin and one latrine for every ten. The basins should be placed in a trough lined with zinc, over which the water-taps are to be fixed. In permanent hospitals earthenware basins, set in marble, are to be preferred. The bath-tubs may be of iron enameled, slate, or wood lined with zinc. One window will be sufficient for this room.

The water-closet should be well ventilated by one of the methods to be hereafter described. The form of latrines to be used is to be determined by circumstances. If water is supplied, any one of the numerous patterns in use which carry the fecal matter at once from the premises will answer. A form used in many of the military hospitals, especially by those in Philadelphia, which consists of a large iron trough, capable of being flooded, and over which the holes are placed, is not suited for hospitals. It always has a bad odor about it, no matter how carefully it is attended to. When water is not introduced into the building, boxes or tubs are to be so placed as to receive the evacuations. These must be scrupulously emptied every morning.

Fig. 28.



GROUND-PLAN OF WARD FOR TWENTY BEDS.

In the accompanying cut (Fig. 28) the arrangement of the ward and offices, as recommended by the Com-

mission to which reference has so often been made, is represented: *a* is the ward, *b* the attendants' room, *c* scullery, *d* water-closet and sink, *e* bath-room and ablution table, *f* ventilated lobbies. This plan is a very excellent one, and scarcely admits of improvement. Others will be given which have been adopted in the large military hospitals erected by the United States during the past year.

The unit of the hospital has now been briefly described. In the next place attention must be called to the various administrative offices which are rendered necessary by the aggregation of several such wards, or by one alone when the hospital is small, to the most approved plans of arranging the wards with reference to each other and to the other buildings which are necessary to a large hospital.

ADMINISTRATIVE DEPARTMENT.—In describing the ward, the offices which are for the immediate use of the inmates have also been considered. Others, however, are necessary for the transaction of the business of the hospital, and for providing for those wants of the patients which they cannot supply for themselves. The rooms thus required in a military hospital are—

1. Surgery.
2. Hospital office and chief medical officer's office.
3. Store-rooms.
4. Medical officer's quarters.
5. Hospital steward's quarters.
6. Apothecaries and nurses' quarters.
7. Kitchen and appurtenances.
8. Laundry.
9. Dead-house.

The size of these rooms will of course depend very much upon the size of the hospital, and the arrangement of them may well be left to the individual preferences of the chief

medical officer, certain general principles being kept in view. Thus the office in which the records are kept, and in which the business of the hospital is conducted, should be easy of access to visitors, and at the same time so situated as to be out of the way of the patients. The surgery should be under the special control of the chief steward, who should himself be a skillful apothecary. Store-rooms should be for three descriptions of articles: for medical supplies, for linen and bedding, and for provisions. Rooms intended as quarters for the officers and attendants should be of ample size and completely fitted up. The officers' rooms should contain at least 225 square feet each, and only one person should occupy each room. Those for the attendants should be of such a size that each occupant should have at least 60 square feet.

The kitchen should be entirely detached from the hospital, or should occupy a part of the building away from the wards. It should be fitted up with ranges and cauldrons as permanent fixtures, and if possible should be supplied with water from a main.

A mess-room should be connected with the kitchen for the convalescents and attendants, and sculleries and pantries should also be attached to it.

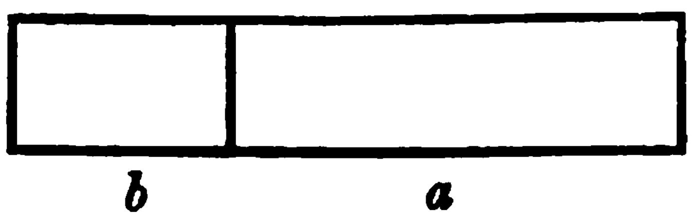
The laundry is an important part of the hospital. It should be a separate building from the establishment, or placed in a remote part of it. Cauldrons supplied with water, which can be heated by steam, washing tubs, ironing machines, etc. should be furnished.

The dead-house should be sufficiently remote from the hospital, should be well ventilated and lighted, and furnished with the necessary means for conducting *post-mortem* examinations.

General Plan of the Hospital.—In building a hospital, the principle is not to be lost sight of that the sick are to be entirely separated from the administrative part of the

building. In fact, they are to have a separate house for themselves. A collection of such buildings constitutes the hospital, which, therefore, has a not indistinct resemblance to a polyp. Reduced to its simplest form, a hospital consists of two parts—the ward and the administration. In the figure, (29,) *a* is the ward, *b* is the administration.

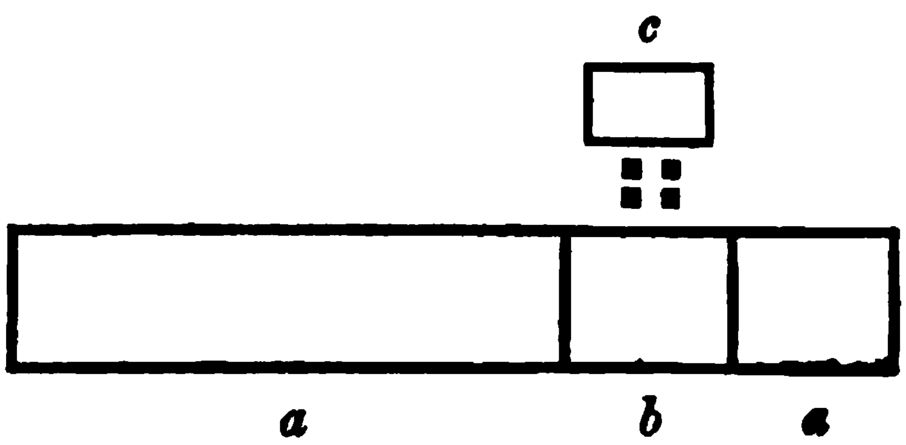
Fig. 29.



The latter is a constant factor, the other a variable one; there may be many wards, but there is only one administration.

In the next figure (30) a slight amplification is made. There are two wards, *a a*; and a detached kitchen, *c*, has been added to the administration.

Fig. 30.



The principle therefore is that the wards form a collection of hospital buildings which center around a nucleus—the administrative department. No other arrangement than that which entirely separates the wards from each other is worthy of consideration, except to receive condemnation. Any other is altogether unfit to meet the necessities of the sick, and affords conclusive evidence that the designer is ignorant of the first requirements of sanitary science. This plan consists in having separate

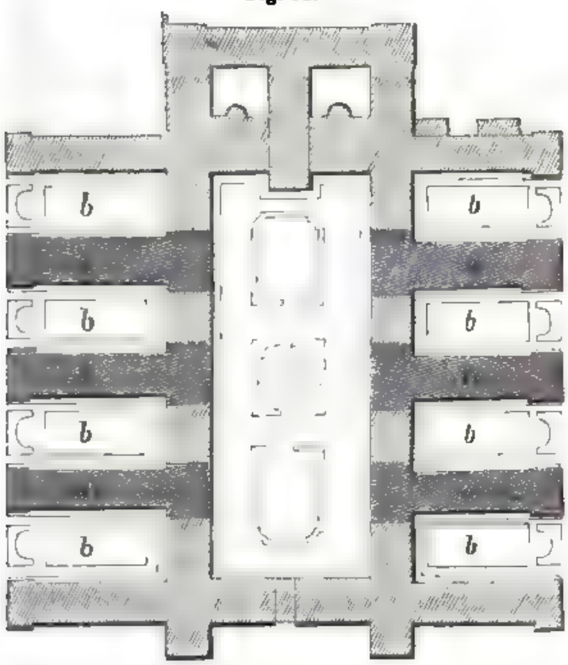
pavilions, built after the model of that already described, and arranged in such a manner as to admit of convenient administration without sacrificing anything essential to the health or comfort of the patients. There are many ways of effecting these objects; and it will be advisable to bring under notice some of the most approved plans of hospitals both in Europe and this country. Among the latter several of the immense structures rendered necessary by the exigencies of the military service of the country, and surpassing in magnitude any hospitals that the world has ever seen, will receive special consideration. In this way it is hoped the student will obtain instruction in the important matters of hospital construction and administration, which will prove both interesting and important to him.

A perfect hospital has never yet been built, and perhaps never will be. It seems to be almost impossible for those having charge of hospital construction to obtain all the means which they deem necessary to insure perfection, and it sometimes happens that when the most ample resources are placed at their command, the hospital falls far short, architecturally and hygienically, of what might have been accomplished. In the descriptions which follow I shall point out not only the meritorious features, but also those characteristics which I consider to be defects.

Among the hospitals of Europe which are regarded as best fulfilling the requirements of hygiene, the Lariboisière, at Paris, is especially to be noted. As long ago as 1786 a commission of the Academy of Sciences, appointed to determine upon the best plan to be followed in rebuilding the Hôtel-Dieu, which had been destroyed by fire, reported in commendation of the system of having separate pavilions constructed. The report was not acted on favorably, but several years afterward the recommendations made were carried out, and the Lariboisière Hospital is the result.

The arrangement of the pavilions and of the several administrative apartments is seen in the accompanying cut, (Fig. 31,) representing a ground-plan of the hospital: *a a*,

Fig. 31.

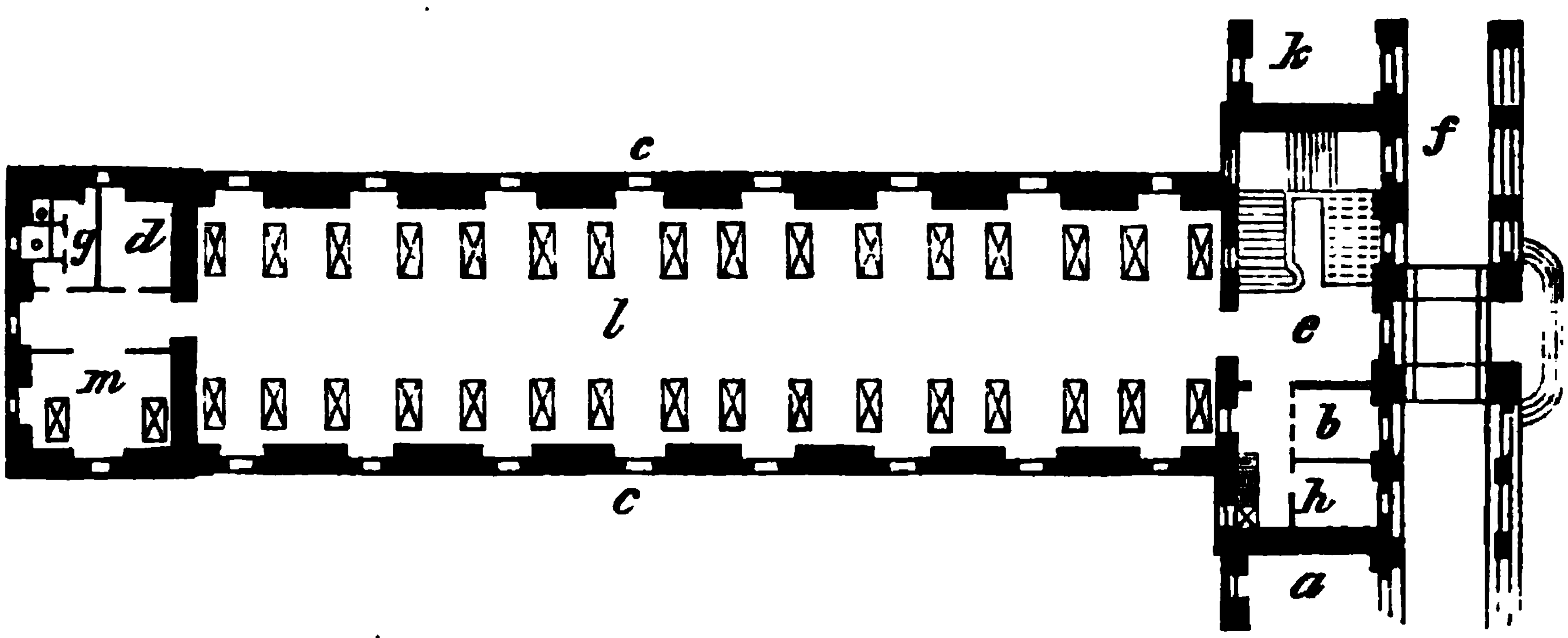


LARIBOISIÈRE HOSPITAL—GROUND-PLAN.

wards; *b b*, open ground. The pavilions, of which there are six, are each three stories high. Each floor contains two wards, one for thirty-two beds and one small one for two beds. There are thus one hundred and two beds in each pavilion. The large wards are 111 feet long and 30 feet wide. There are thus 3330 square feet of surface, equivalent to a little over 104 square feet to each bed. The wards on the first floor are 17 feet 6 inches high, on the second floor 16 feet 8 inches, and on the third 16 feet 4 inches. The cubic space to each bed is thus on the first floor 1860, on the second 1740, and on the third 1700 feet.

The details of the construction of a flat are seen in the accompanying plan, (Fig. 32:) *a*, the library; *b*, visitors'

Fig. 32.



DETAILS OF WARD—LARIBOISIÈRE.

room; *c*, exercise grounds; *d*, discharging shaft; *e*, staircase; *f*, corridor; *g*, latrines; *h*, office; *k*, mess-room; *l*, large ward; *m*, small ward. The windows are sixteen in number, eight on a side; each is 4 feet 8 inches wide, and extends nearly to the ceiling. Each pavilion is 55 feet high, and the distance between them is 64 feet. An open corridor runs entirely around the whole structure, connecting the pavilions to each other and to the administrative departments. There is a free circulation of air therefore from one side to the other. The mess-rooms are eight in number, and are but one story high.

The administrative offices of the building are represented, in the ground-plan of the hospital, by the light shaded parts.

Although the Lariboisière is a vast improvement on the great majority of hospital plans, it has several serious faults. In the first place, the pavilions have too many stories—one, or at most two are to be preferred. The wards are consequently too much crowded together, and there cannot be the same facility for conducting the ad-

ministrative departments as in hospitals of a less number of floors. Much time is lost and fatigue incurred to the officers and attendants in having so many flights of stairs to mount and descend. Moreover, the third floor of a building is not so healthy as the lower ones. The second is the healthiest, the first next, and the third least of all.

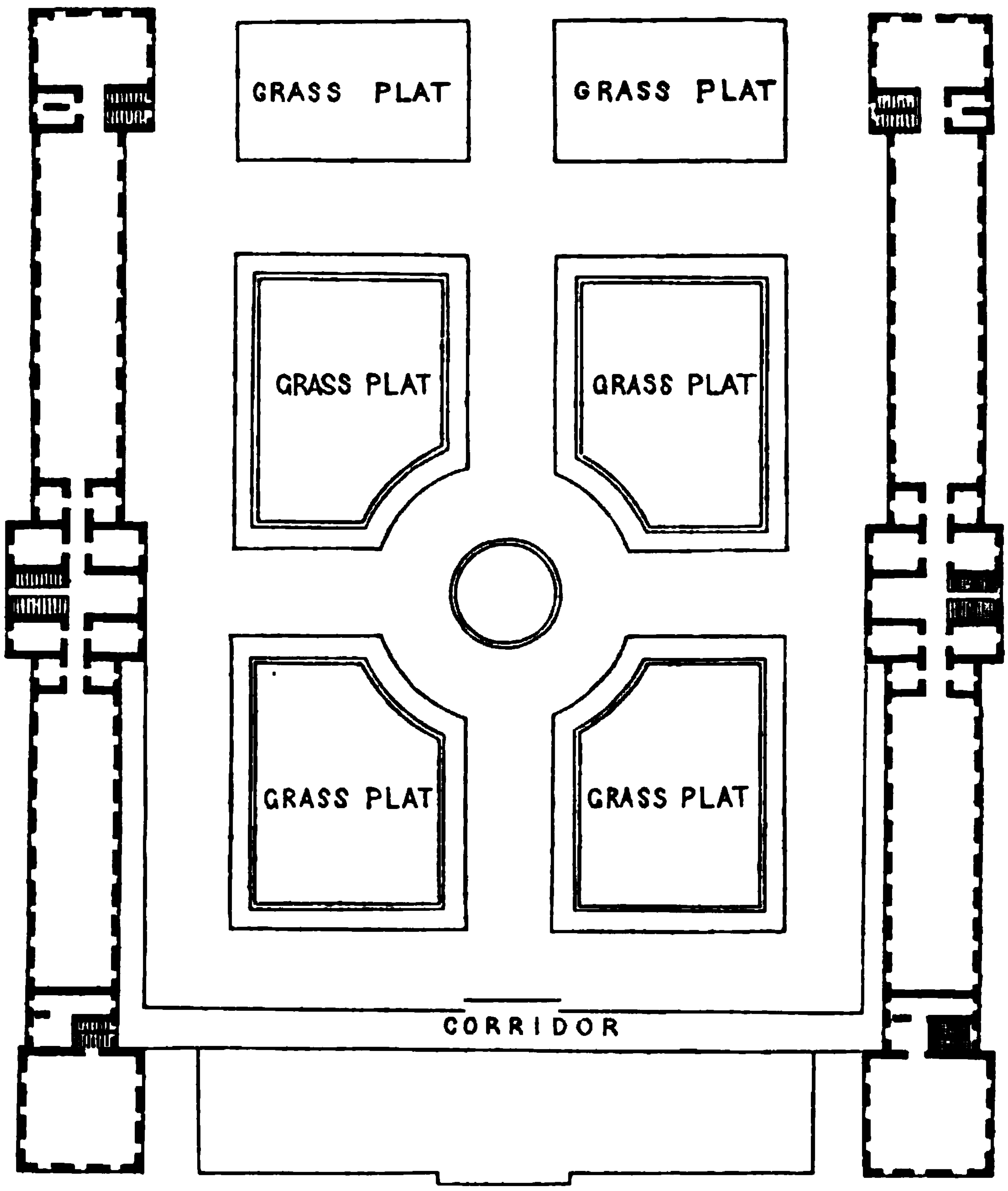
Another objection is found in the fact that the pavilions are too close together, so much so that in the morning and toward sunset the lower floors are shut off from the direct rays of the sun. The distance between the pavilions should be at least double the height, in order to allow of the free circulation of air, diminish the injurious results of bringing many sick and wounded together, and admit of each ward receiving direct sunlight at some time of the day.

In the new military hospital at Vincennes a different manner of arranging the pavilions has been adopted, which allows of still greater advantages as regards the circulation of air and light. In the accompanying cut (Fig. 33) a ground-plan of this institution is given: *a*, offices, guard-room, chapel, and other administrative apartments; *b*, kitchen, linen-room, and accommodation for 18 sisters and 308 soldiers; *c*, pharmacy, baths, and accommodation for 21 officers and 308 soldiers.

The ward pavilions are each 340 feet long, and have three stories and an attic. The wards are of different sizes; the larger ones are 135½ feet in length by 26 feet 4 inches in width. They contain each 40 beds, and there are consequently about 90 superficial feet to each bed. The wards on the first floor are 15 feet high, and those of the second and third 13 feet 7 inches. The attic wards are not ordinarily occupied. In the wards on the lower floor the allowance of space is 1334 cubic feet per bed, on the wards of the upper floors it is 1200 cubic feet. The

windows are 5 feet 2 inches wide and 9 feet 2 inches high. The proportion of windows to beds is the same as in the Lariboisière.

Fig. 38.

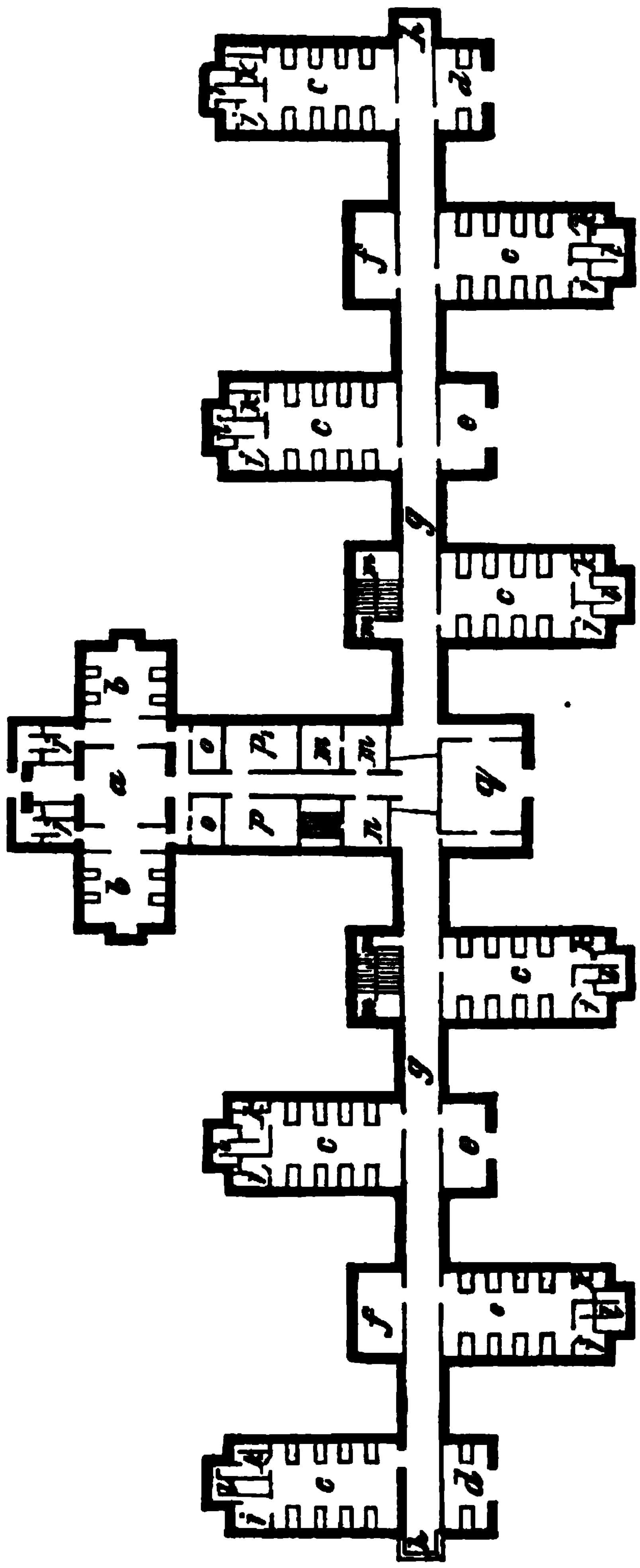


MILITARY HOSPITAL AT VINCENNES—GROUND-PLAN.

The military hospital at Vincennes was commenced in April, 1856, and opened for the reception of patients June 1st, 1858. It has accommodations for six hundred and sixty-five sick—twenty-one officers and six hundred and forty-four soldiers. A barrack intended for the accommodation of the nurses is not yet constructed. The entire cost of this hospital is 2,479,000 francs, or about 500,000 dollars.

The objectionable features of the Vincennes hospital are that it has too many stories, and that to pass from one pavilion to another there is but one way. In other respects it is very well arranged.

Fig. 34.



BLACKBURN HOSPITAL.

The Blackburn Hospital, near Manchester, England, is very well planned, but the wards are too small for economical and convenient administration. The accompanying cut, (Fig. 34,) from the admirable work of M. Hus-

son,* represents the plan of the first floor: *a*, operating theater; *b*, wards for the reception of patients operated upon; *c*, wards; *d*, wards for special cases; *e*, mess-rooms; *f*, reading-rooms; *g*, corridor; *h*, balcony; *i*, discharging shaft, by which soiled linen, dressings, etc. are passed to the basement; *k*, bath-rooms; *l*, latrines; *m*, sitting-rooms and rooms for officers; *n*, kitchen for officers; *o*, rooms for officers; *p*, bed-rooms for nurses.

The larger wards in the hospital are 39 feet long, 23 feet wide, and 16 feet high. As there are but eight beds in each of these wards, the allowance of cubic feet of space for each is 1794 feet. Each ward has 10 windows, 3 feet wide and 9 feet high. They extend from 2 feet 7 inches above the floor to 4 feet 9 inches from the ceiling. In this last interval ventilating openings, covered with plates of perforated zinc, are made.

The floors of the wards are of Norway pine, and are soaked with a water-proof material. The walls and ceilings are coated with Parian cement.

The kitchens for the patients are in the basement, and the food and fuel are raised by means of dumb-waiters.

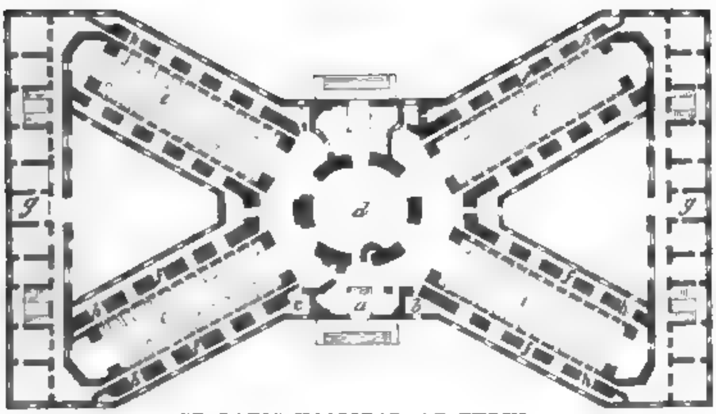
Up to the present time the cost of the Blackburn Hospital has been, including the ground, 85,000 dollars, and it is estimated that an additional sum of 34,000 dollars will be required to finish it. It will contain about 140 patients.

It is to be regretted that the wards of this hospital were not so far extended as to admit of their accommodating thirty-two or forty-eight patients each, which could have been done with but comparatively small additional expense. As it is, the Blackburn Hospital must be regarded as one of the most admirably arranged in Great Britain. As will be seen hereafter, two of the military hospitals of the United States are constructed upon a somewhat similar plan.

* Etude sur les Hôpitaux. Paris, 1862.

The hospital of Saint Louis, at Turin, is somewhat unique in its arrangements, and possesses some features in its construction worthy of consideration by those who have the designing of hospitals committed to them. M. Gaultier de Claubry* calls attention to it, and M. Armand Husson† cites its plan as deserving of imitation in some particulars. I can bear testimony to its excellent management, and to the facility with which it is administered. As will be observed from the accompanying plan, (Fig. 35,) which represents the ground-plan of the first floor, the pavilions are arranged so as to form a figure resembling the letter ⋈.

Fig. 35.



ST. LOUIS HOSPITAL, AT TURIN.

In the plan *a* is the vestibule; *b*, reception-room; *c*, principal staircase; *d*, chapel; *e*, wards; *f*, passage behind the beds; *g*, offices of various kinds; *h*, latrines. The passage behind the beds serves for the removal of any patient from the ward who has died, or who is to be operated upon, without the other patients having the matter brought to their attention. Behind each bed is a door communicating with

* Annales d'Hygiène, 1859, tome xi. p. 118.

† Op. cit., p. 471.

the passage through which the bed is taken, curtains having in the mean time been drawn around it.

The principal objection to be urged against the Saint Louis Hospital is the fact that the windows do not open directly from the wards to the external air, and that the courts are not sufficiently open to the free circulation of the atmosphere.

The chief advantageous feature is the slight distance that the wards are placed above the ground, by reason of which circumstance the convalescents are enabled to take a moderate amount of exercise without being obliged to descend and ascend long flights of steps, than which nothing is more fatiguing.

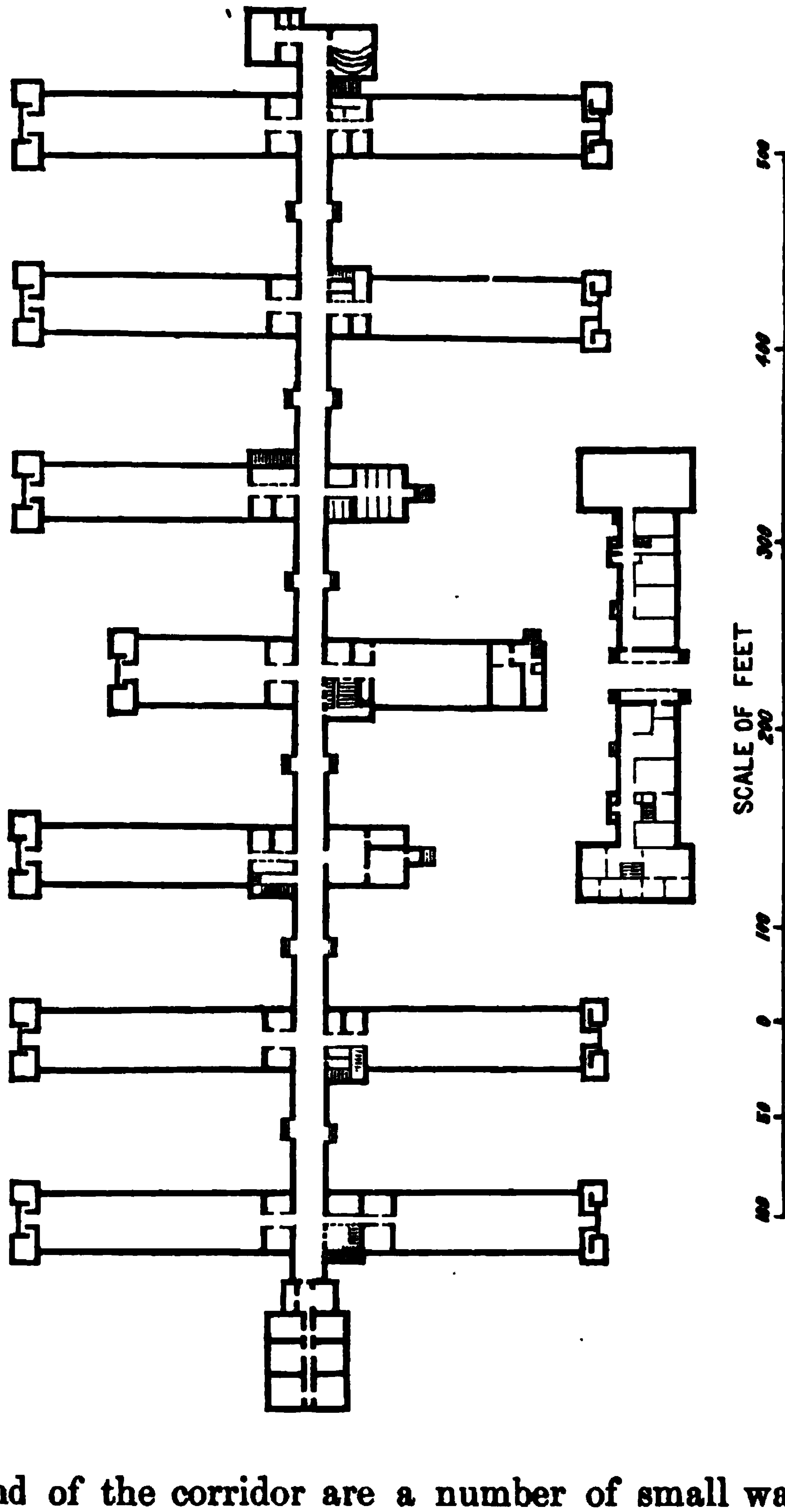
Among the German hospitals, the Charité and Bethaney at Berlin, the Allgemeines Krankenhaus and Wiedner Krankenhaus at Vienna, and the Hospital zum Heiligen Geist at Frankfort, though not so perfect in their construction as those specially referred to, have some good points about them. As a rule, however, the German hospitals are not to be compared to the French so far as hygienic considerations go. Most of them are either rectangular structures or else are so arranged that the wards open on close corridors, like those at Hamburg, Bremen, Rotterdam, and Zurich, already cited.

Among the proposed hospitals, those to be built at Woolwich and Malta, if constructed according to the plans which have been approved, will be very admirable structures.

The ground-plan of the first floor of the Woolwich Hospital is shown in the cut, (Fig. 36.) The detached building contains the administrative offices, and is three stories high, besides the basement. The pavilions are arranged in pairs, opening on a corridor at right angles to its length. At the distant end of each ward are the lavatory and bath-room, and water-closet, at the other extremity the scullery

and nurses' room. Seven of the wards on this floor are for thirty-two beds each, and three for twenty-eight beds. At

Fig. 36.

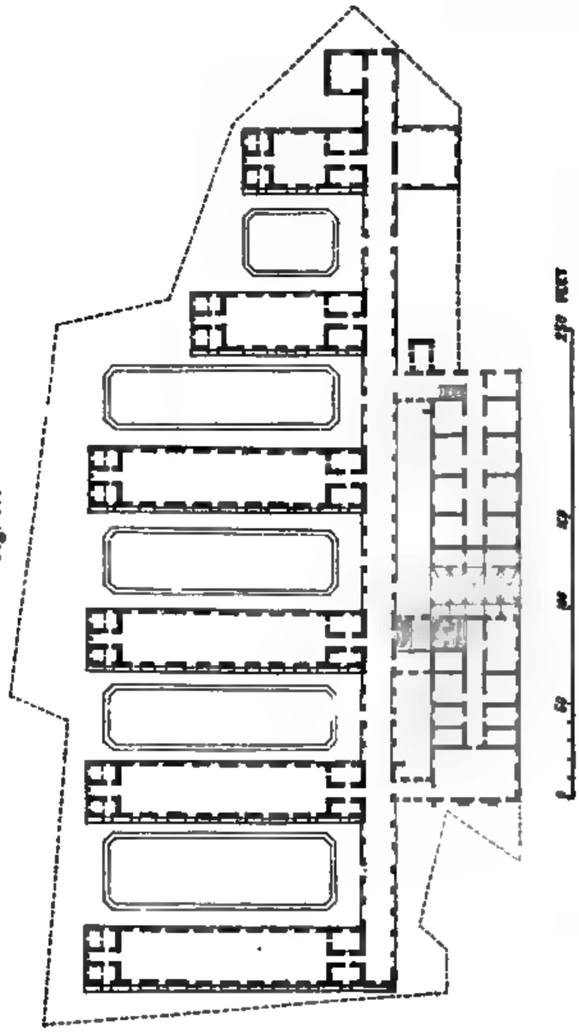


PROPOSED MILITARY HOSPITAL AT WOOLWICH.

one end of the corridor are a number of small wards for lunatics, and at the other the operating ward and operating

theater. The pavilions are two stories high, exclusive of the basement. There is no objection of any consequence to offer to the general arrangement of this building, which

Fig. 37.



MILITARY HOSPITAL AT MALTA.

will, when completed, be a model military hospital. It will contain six hundred and fifty beds.

The proposed military hospital at Malta, (Fig. 37,) though

not so complete in its arrangements as the one at Woolwich, possesses certain advantages over that hospital. Being built in a bastion of the fortification, it was necessary to make the pavilions of different sizes, in order to lose no ground. This, however, allows of the freer access of air to the wards. The pavilions are two stories high, and contain each two wards. The water-closets and bath-rooms are at the far extremity of the wards, and the nurses' rooms and sculleries at the end joining the corridor. The administrative building is in front, and is connected with the main corridor by passage-ways, two courts intervening. Each bed has about 96 superficial feet and 1540 cubic feet of space.

In the next place, we come to the consideration of the hospitals of the United States; and we shall find that in hygienic requirements they are, with few exceptions, fully equal to the best which have been erected in Europe. The Pennsylvania Hospital at Philadelphia is built upon a plan very similar in its general features to the plan recently adopted by the British Government for its regimental hospitals. It consists of a central administrative building, with pavilions extending from two of its opposite sides. These pavilions are two stories high, exclusive of basement. The allowance of space to each is somewhat over 1700 cubic feet. There are detached buildings which are devoted to syphilitic and labor cases.

There are only two of the many large and admirable civil hospitals of the United States to which we design drawing special attention, and these are the Free City Hospital of Boston and the Episcopal Hospital of Philadelphia. In some respects these hospitals are superior to any which have been constructed in any part of the world, and so far as can be perceived fulfil all the requirements of sanitary science.

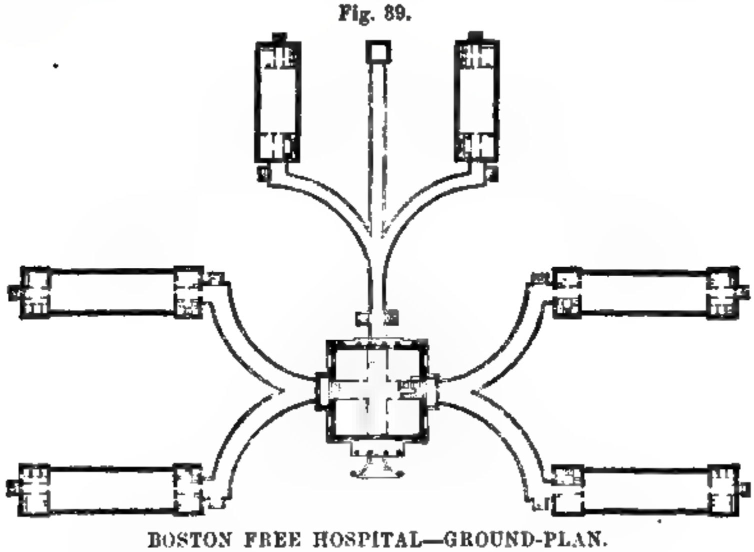
The accompanying cuts (Figs. 38 and 39) exhibit a perspective view and a ground-plan of the principal floor of the Free City Hospital, now being erected in the City of

Fig. 38.

BOSTON FREE HOSPITAL—ELEVATION.

Boston, and which was designed by Henry G. Clark, M.D., one of the surgeons of the Massachusetts General Hospital.

Fig. 39.



BOSTON FREE HOSPITAL—GROUND-PLAN.

The particular style chosen is the modern style of Renaissance architecture, a style which, from its own inherent

beauties, not less than from its almost universal susceptibility of adaptation to structures of a dignified and monumental character, stands confessedly at the head of all the forms of modern secular architecture in the chief capitals of the world.

In this case, while all the most essential sanitary conditions have been well considered and secured, the designer has not failed to avail himself of so rare an opportunity for architectural effect. The very necessities of the plan, as described above, are of themselves the sources of some of the highest architectural beauties. A central building, with a portico surmounted by a bold and picturesque dome, and connected laterally by means of open colonnades, with advanced pavilions of a corresponding style of architecture, presénts in its own absolute requisitions the groundwork for artistic effect of the highest order, and such as in buildings intended for other and different purposes, great additional outlay and serious inconveniences of arrangement have sometimes been submitted to in order to attain. The primary and secondary masses of light and shade in the composition are, by this arrangement, made to glide into each other by the most gradual transitions of effect, while the open screens of double columns in the corridors curve round into different relations of position and shadow with each footstep of the advancing spectator.

The design embraces six separate pavilions radiating from a central structure, but entirely disconnected with this building excepting by corridors or walks, each of the quadrant of a circle in form. The pavilions are intended to be so grouped with reference to the central building as to be located in parallel rows of two pavilions each, on three sides of the central building, at the distance of eighty feet therefrom. The ends of the pairs of pavilions face three of the four streets which surround the site, and are located one hundred feet back from the margin of the

site or side of the street against which they face. The principal façade of the plan, which comprises two of the pavilions and the central building, is designed to be located one hundred feet from the margin of the site, while the center building itself is removed to a distance of one hundred and forty feet from the street.

The four larger pavilions of the six will accommodate at least 50 patients each, and are 117 feet in length and 28 in width. The remaining two pavilions are intended for 25 beds each, and measure 89 feet in length and 28 feet in width. All of them are of two finished stories in height, with a basement story, which is connected, by a little tramway through the corridors, with the central building and all the other pavilions. The central building is 60 feet square and three stories in height, and is intended exclusively for the officers' apartments, offices, kitchens, theater, and other apartments requisite for the administration and supervision of the whole institution.

The pavilions are so located as to be one hundred feet apart in the clear, and at an average distance of one hundred feet from the central building, thus securing the most ample space for light and ventilation to and between the several buildings composing the complete design. By this arrangement and position any one of them, as they each have separate kitchens, etc., may be made a complete and independent hospital of itself, so that the plan may be extended at any future time, as circumstances may require.

In this hospital every precaution seems to have been taken to secure the hygienic advantages which such institutions should possess. The larger wards are 100 feet in length and 28 in width, the remaining 17 feet of the length of the pavilions being appropriated to the water-closet, bath-rooms, and nurses' room. Each patient will therefore have over 100 square feet of surface and about

1600 cubic feet of space. The windows are large and numerous. There being but two floors of wards, there are consequently but 50 patients under one roof.

In the smaller wards the superficial area and cubic space allowed to each patient are still greater. These wards are for such cases as require the most ample allowance of room.

The dead-house is conveniently placed in the rear immediately opposite the center of the administrative building.

In extending this hospital—should such a procedure become necessary—it can readily be done by prolonging the two anterior corridors, so as to continue them in parallel lines, and building pavilions from them corresponding to the others, and also by following a similar plan with the two corridors from which the small pavilions are extended. The present plan is intended for 250 patients, with the necessary number of officers and attendants.

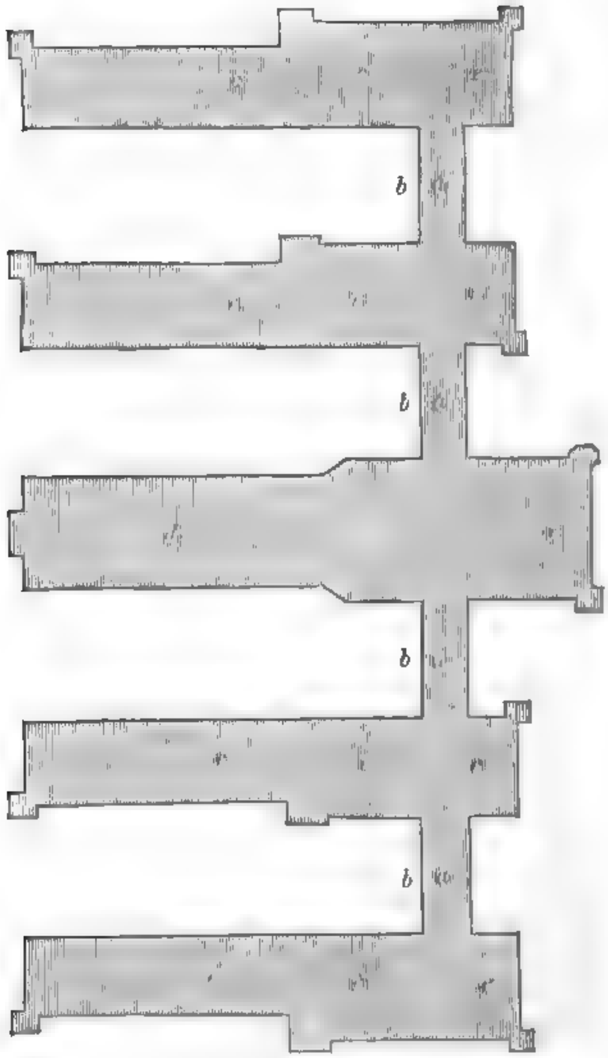
It is not to be denied that a system such as that upon which the Boston Free Hospital is constructed is much more expensive than when the wards are huddled together, and party-walls and few windows are the result. So far, however, as the interests of the inmates are concerned—and if they cannot be made paramount to every other consideration, hospitals had better not be built—there can be no doubt of its advantages.

For a military hospital, the plan in question would answer admirably, slight alteration in the administrative building only being required.

The Episcopal Hospital of Philadelphia is situated on the outskirts of the city, in a locality which is removed from any endemic sources of disease. In architectural finish and in completeness of detail, in all that regards the comfort and hygienic condition of the patients, this hospital is not excelled by any other in the world. It consists of a central building, containing a chapel, operating

theater, etc., from which a corridor proceeds on each side.

Fig. 40.



GROUND-PLAN OF EPISCOPAL HOSPITAL, PHILADELPHIA.

From this corridor the pavilions are built at right angles. The material is a dark sandstone. The halls, floors, and

stairs are of stone, and the floors of the wards of yellow pine, saturated with a varnish impermeable to water. There are two floors of wards, besides an attic for special cases, in each pavilion. In addition, there are basements, in which are the kitchens, store-rooms, etc., connected with each other by means of a subterranean passage, through which a railway passes. Fig. 40 represents the ground-plan of the first floor: *a a*, corridor; *b b*, veranda; *c c*, ward pavilions; *d*, chapel; *e e*, small rooms for private patients.

The main wards are 30 feet 10 inches wide by 120 feet long. There are seven windows on one side and eight on the other, besides two in one end. These wards contain 30 beds; each patient has therefore over 120 square feet of surface, and as the wards are 16 feet high, there is an allowance per patient of 2000 cubic feet of space. The water-closets and bath-rooms are at each end of the ward and outside of it. A nurses' room, scullery, dining-room, library, and day-room, besides several closets, are attached to the ward. The details of a ward pavilion are given in Fig. 41: *a*, ward; *b b*, water-closets; *c c*, bath-rooms; *d*, nurses' room; *e*, scullery; *f*, dining-room; *g*, ward-library and day-room; *h*, clothes-room; *i*, dumb-waiter; *k*, corridor; *l l*, closets.

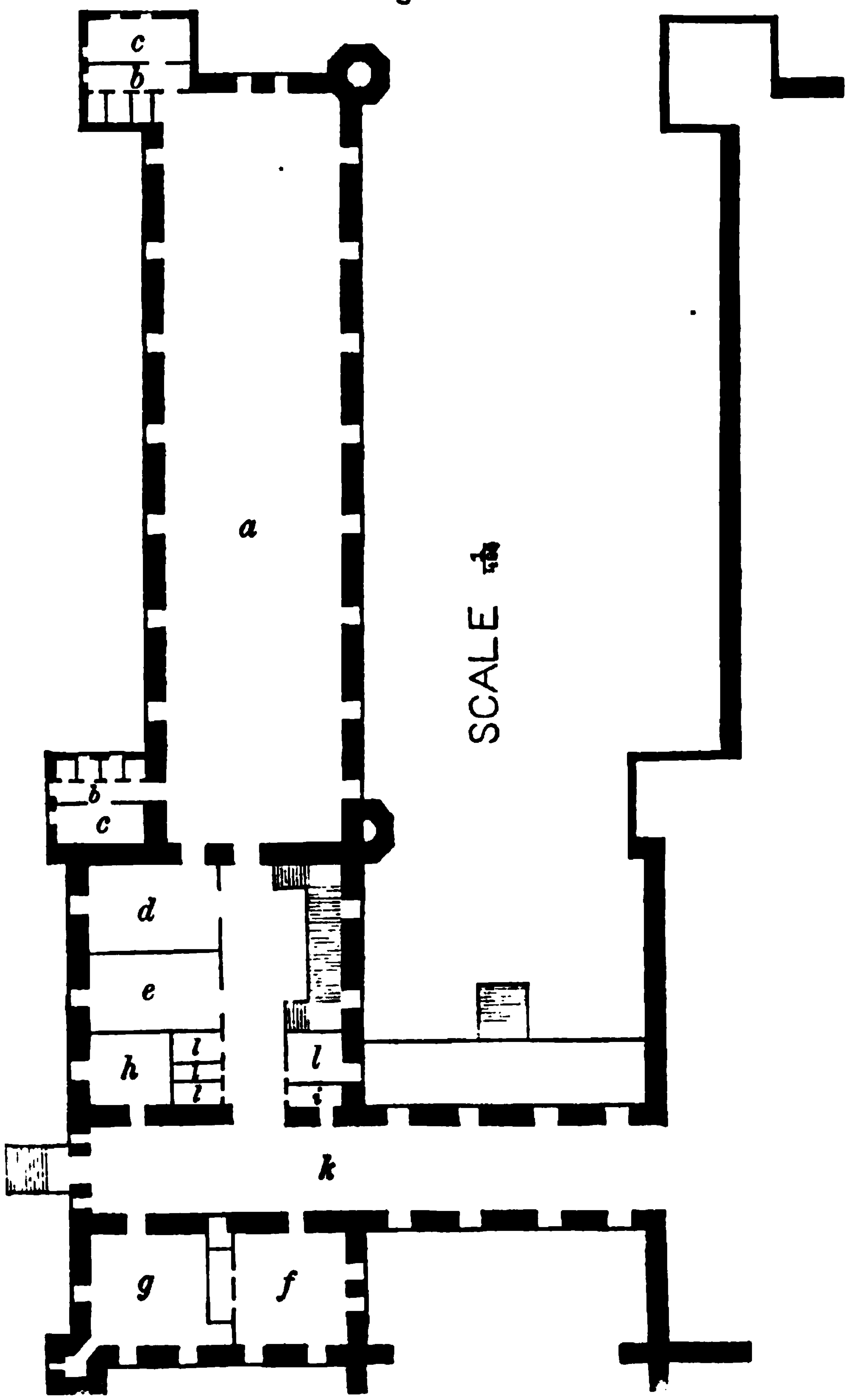
The open spaces seen in the walls represent sections of the ventilating flues. These flues all converge to a large chamber under the eaves of each ward, which opens by a shaft to the external air, and which is heated by steam contained in a coil of iron pipe. Fresh air is admitted by other flues at the ends of the wards, and is heated by steam before its entrance.

The operating theater is in the central pavilion on the upper floor. The capacity of the hospital is fixed at 325 beds, including those for private patients in the small rooms of the central pavilion.

The permanent military hospitals of the United States

are, as we have said, of little importance as models. None of them are built after the plans which have been adopted

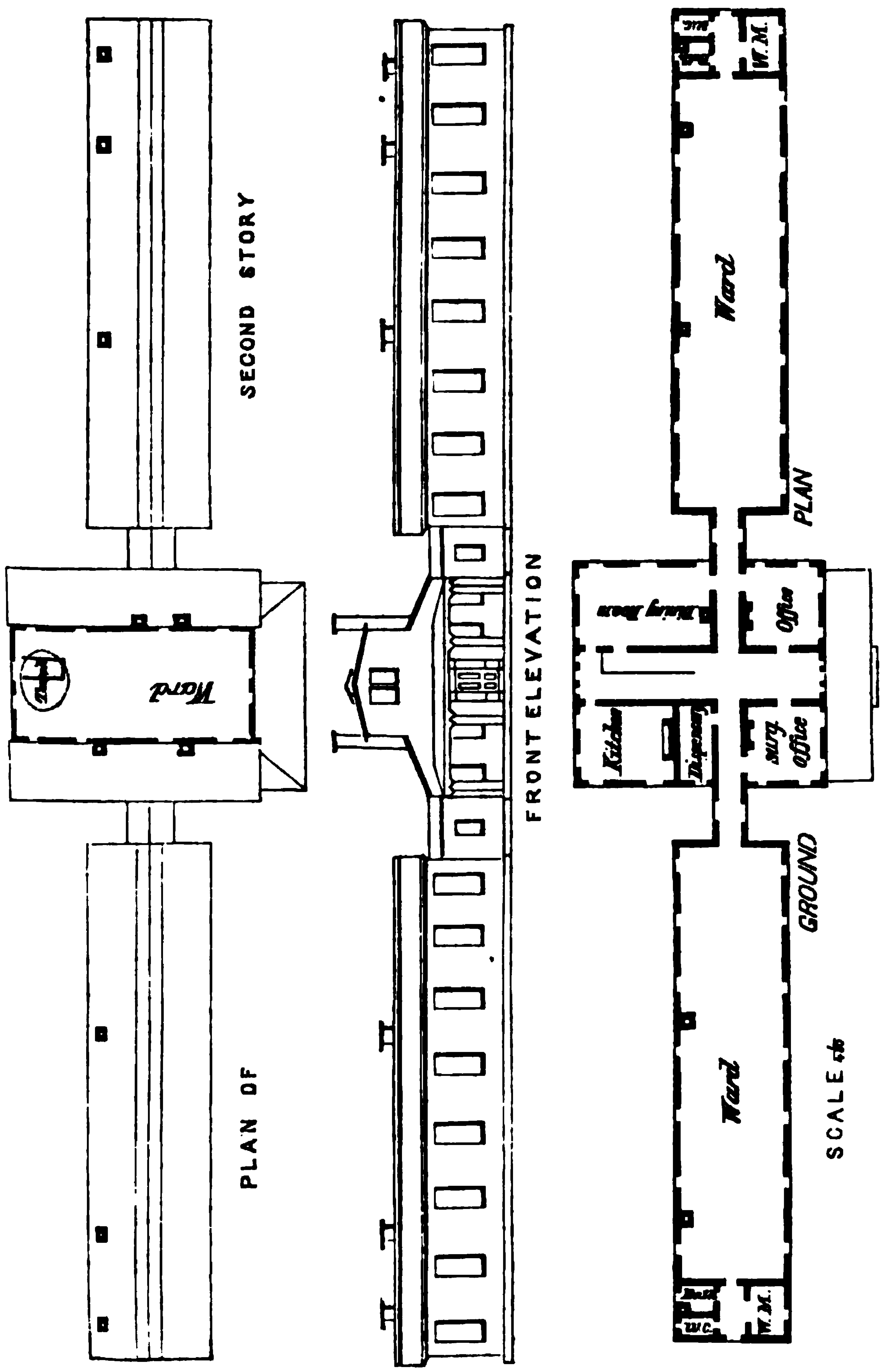
Fig. 41.



DETAILS OF WARD PAVILION, EPISCOPAL HOSPITAL.

by hygieists as best coming up to the standard required by sanitary science. In Fig. 42 the elevation and ground-

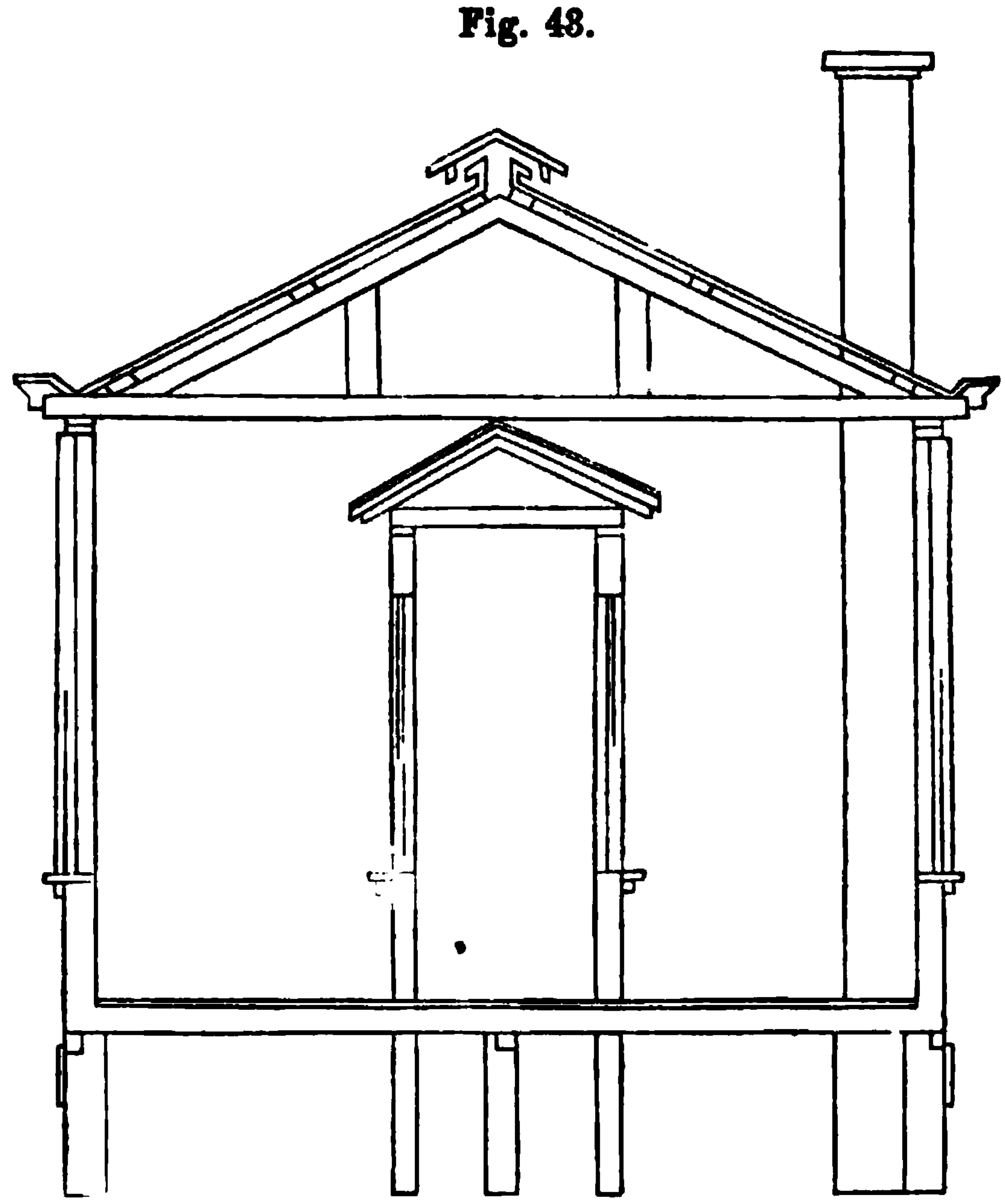
Fig. 42.



POST HOSPITAL AT FORT DELAWARE.

plan in outline of a permanent hospital, which it is proposed to erect at Fort Delaware for the garrison of that post, are shown. The central building is two stories high, and contains a ward on the upper floor for special cases of disease. The two wards in the pavilions are for 28 patients each. These wards are 25 feet wide, 80 feet long, and 14 feet high, to the eaves. The walls will be of brick throughout, studded and plastered. The wards will be unceiled, the rafters being plastered to the ridge, which is left open, as shown in the section, (Fig. 43.)

Fig. 43.

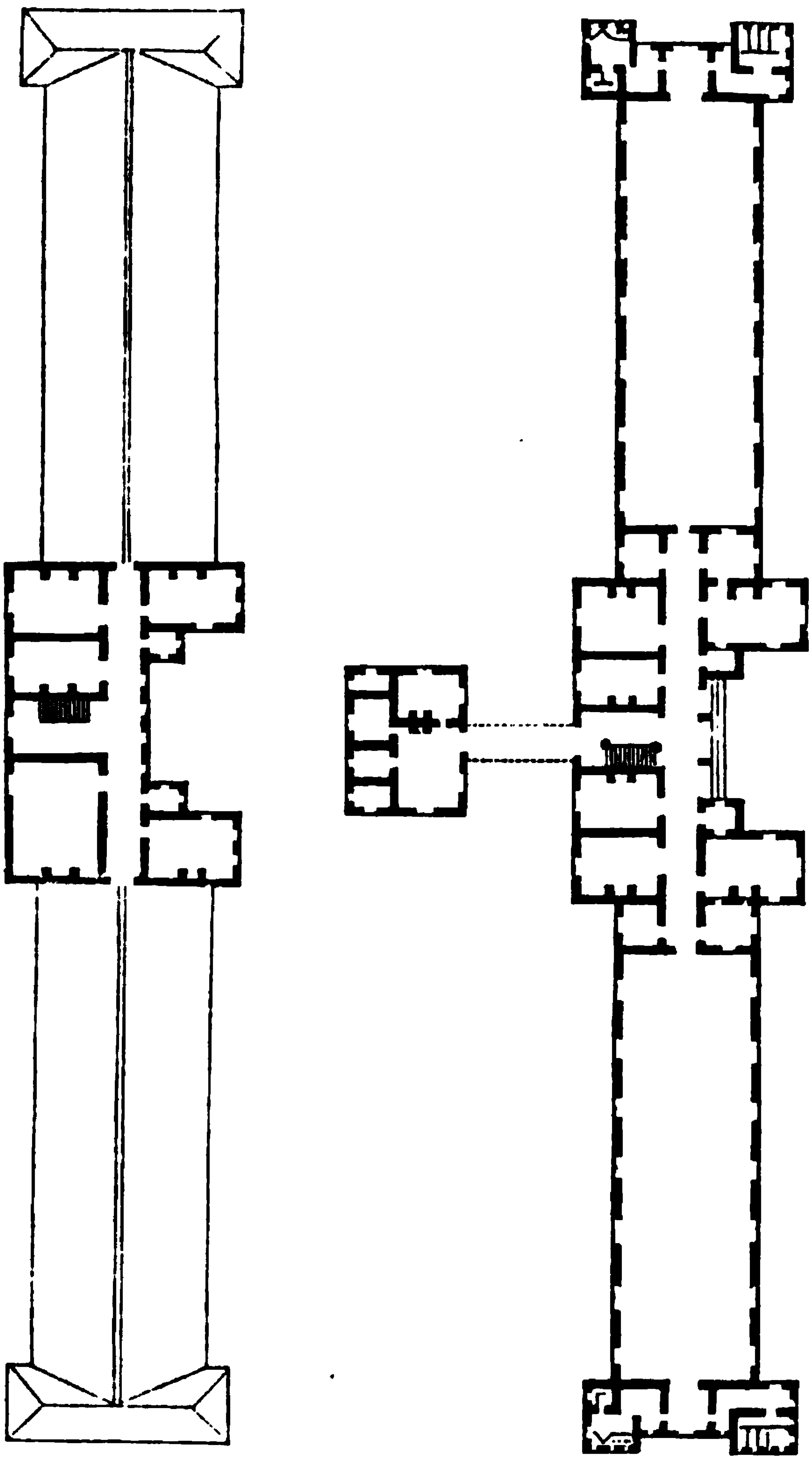


SECTION OF WARD, FORT DELAWARE HOSPITAL.

In Fig. 44 the ground-plans of the British regimental hospital, proposed by the Commission of Inquiry, are given. The kitchen is entirely detached from the main building, which is two stories high. The wards are but one story. Nothing is stated in regard to any special means for ventilation.

In the next place we come to the consideration of *temporary military hospitals.*

Fig. 44.



GROUND-PLANS OF BRITISH REGIMENTAL HOSPITAL.

The erection of temporary military hospitals is a subject of vast importance. If the army is engaged in distant regions it often becomes necessary to build such structures, and even on its own soil no government can maintain as

permanent institutions a sufficient number of hospitals to meet the wants of a large army in time of war. The plans to be followed in the construction of these temporary hospitals will be best made apparent by descriptions of some of those which have been built since the commencement of the rebellion. It will be found that never before have such vast structures been erected for the reception of the sick and wounded of an army, or so much care bestowed by a government in providing them with everything calculated to add to the comfort of their inmates. Millions of dollars have been spent in building these hospitals, and millions more in fitting them up. Especial care has been taken to secure every hygienic advantage in the way of fresh air, abundant light, an ample supply of water, efficient drainage, etc., until, except as regards the less permanent character of the material of which they are built, these temporary military hospitals rival in the completeness of their arrangements the best permanent hospitals of the world.*

The present chapter concerns only those institutions which belong to the class called general hospitals. General hospitals are usually placed beyond the immediate vicinity of an army, and are intended for the reception of the sick and wounded, irrespective of the regiment or corps to which they belong. Field and regimental hospitals will engage attention in a subsequent chapter.

In the selection of sites for military hospitals the principles already enunciated should prevail as far as is practicable. On many accounts it is best to place them in the vicinity of cities or large towns. They are thus generally

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* I wish to express my high appreciation of the liberality and enlightened views with which the Quartermaster-General has acted in ordering the construction of the hospitals desired, and of which plans were furnished by the Medical Department, and for the solicitude he has always manifested to do all in his power to assist the medical officers in their efforts to provide for the sick and wounded of the army.

of easier access, and are more within reach of the supplies of various kinds which are required to maintain them. They should not be too far from the army to which they are more immediately attached, nor too near to impede operations, or require large forces for their protection.

They should consist but of one story, both on account of the greater facility with which one-story buildings are administered, and because the noise, which would incommode those of the lower wards, from the patients and others walking on the floors of the upper, is avoided. Each ward should be isolated from its fellows. Experience has definitely established the propriety of this measure, and it is now carried out in all well-planned hospitals, whether civil or military. Each ward should have its own latrines, bath and ablution room, and nurses' room. It should be raised at least one foot above the ground, the space below being left open to the outside air..

The ventilation for summer should be provided for by leaving an opening, ten inches wide, at the ridge, along the whole length of the ward. This opening should be covered by a roof projecting at least two feet on each side, and elevated about four inches above the lower roof. A narrow strip should be placed along the margins of the opening to still further guard against the entrance of snow or rain. The arrangement is shown in section in Fig. 43.

Holes should be cut in the sides of the wards under the beds, capable of being closed by a sliding-door, so as to allow of the free entrance of the external air.

This system of ventilation is very effective. The sun heats the roof whereby an upward current is established, and the air of the ward is constantly kept renewed. Such wards are always comparatively cool and fresh. The experience of the summer of 1862, when many hospitals ventilated on this principle were in operation, and when they were, from the large number of sick and wounded suddenly

thrown upon them, crowded to the utmost limits consistent with sanitary requirements, demonstrated that the air was always cool, and free from offensive odors.

In the northern parts of the United States it may become impracticable to keep these ventilators open during the winter months, and at the same time maintain the necessary degree of heat in the wards. In such cases other means of ventilation are rendered necessary. The arrangement adopted in the military hospitals is based upon the principle of introducing, in cold weather, all the fresh air required for the constant change of the atmosphere within the wards at or near the stove, so that it shall be moderately warmed before entering the room, and thus in a measure to avoid the unpleasant cold currents so annoying in a room heated exclusively by direct radiation.

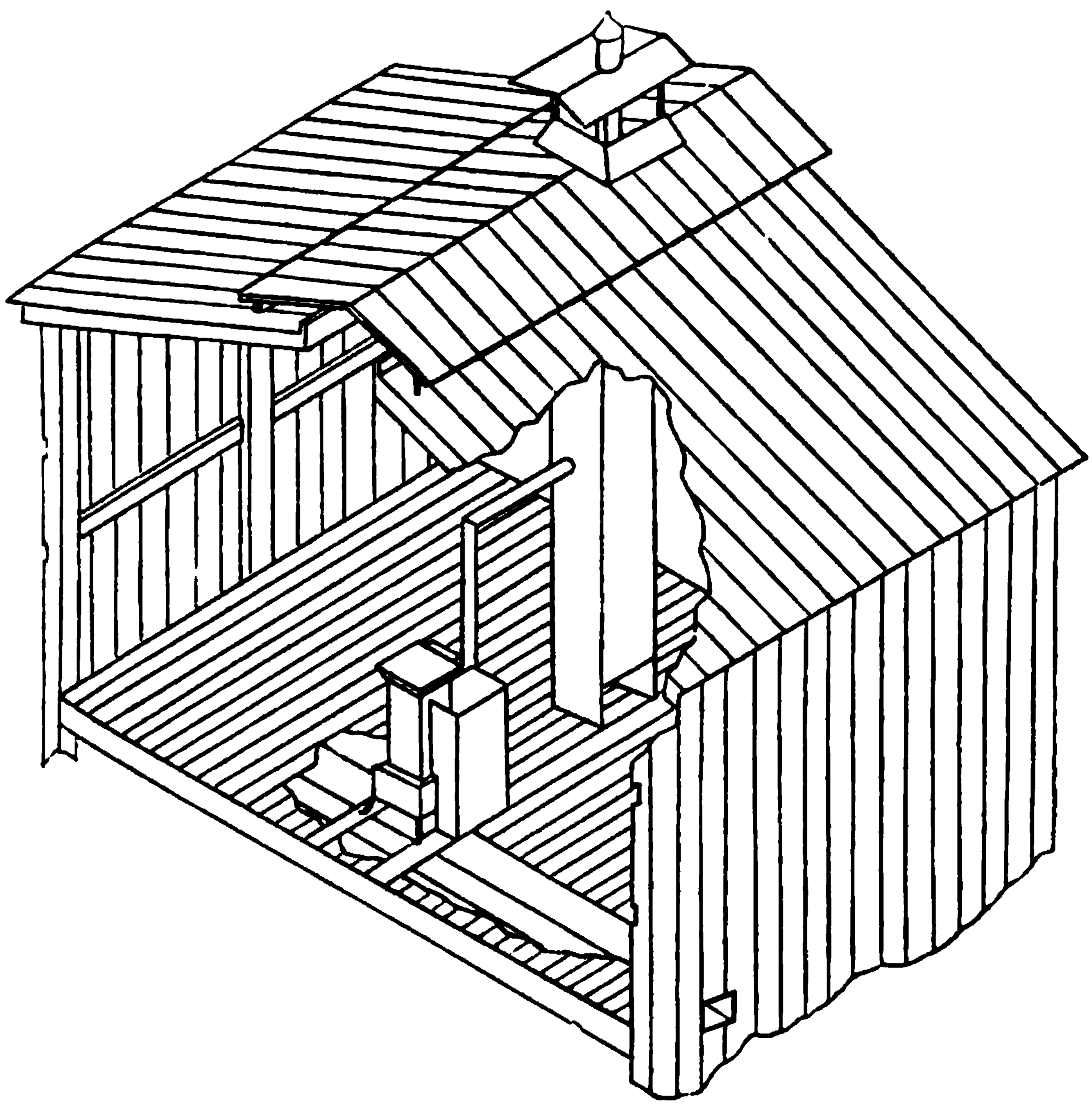
If the means of exit for the vitiated air are sufficient in a room heated by an ordinary stove, the air enters from without with the external temperature, through any cracks about the doors or windows, and thus irregular currents are excited.

To obviate this difficulty, and at the same time provide a sufficient amount of fresh air, holes are cut in the floor under the stoves, and fresh air is brought to them by means of wooden boxes passing between the floor and the ground to the side of the building. A zinc jacket partially incloses the stove, and serves the purpose of retaining the air long enough in contact with the heated metal to receive a portion of its temperature. By this means fresh air is provided and is heated before it is distributed throughout the ward.

For the exit of the impure air square wooden boxes are erected in the ward, passing from the floor through the ridge of the roof. These boxes are open on two sides near the floor, and one side consists almost entirely of a door extending throughout nearly the whole length of the shaft.

To each stove there is one of these shafts or boxes, and in order to cause a current through them the stove-pipes pass into them and thus emerge from the roof. The arrangement is shown in perspective in the accompanying cut, (Fig. 45.) The results obtained from this system have been exceedingly satisfactory. It is extremely simple, and is easily regulated.

Fig. 45.



WINTER VENTILATION OF TEMPORARY HOSPITALS.

During the late war with Great Britain several temporary general hospitals were erected, and were highly commended at the time for their completeness. In order that it may be seen how wretched these structures were, and how erroneous were the principles which then prevailed relative to sanitary matters, I transcribe the following

extracts from the work of Dr. Mann,* then a surgeon of the army.

"Dr. Tilton, Surgeon-General of the Army, with a mind possessing correct principles of philosophy, desirous of introducing a system of economy creditable to himself, suggested hospitals upon a novel plan. They are built one story in height with round logs, having a fire-place or hearth in the center; without a chimney, the smoke ventilated through an inverted wooden funnel affixed to an opening in the roof; the floors of the rooms earth, in the true aboriginal style. He thinks them an improvement as they respect health. Hospitals of this description, he believes, obviate diseases which have their source from impure air of crowded rooms, which is generated from animal filth. The doctor is believed to be correct in his observations so far as wooden floors retain infectious principles, while earth floors absorb or neutralize them. Examples are not wanting to demonstrate that infectious principles attached to wood retain their activity during a long time. An improvement which is truly philosophical in theory, cannot be carried into practice under all circumstances. The plan proposed may, in southern districts or milder climates, fulfil the benevolent intentions of its learned projector. These hospitals are for winter months. During the hot seasons, tents are the best military hospitals. When snow covers the earth to a considerable depth, it dissolves next the surface. The water irrigates under the bottoms of the timbers which compose the outer wall of the hospital, by which the earth floors are rendered uncomfortable from moisture, and the beds dirty. In a hospital on the above plan the smoke, in its ascension, may convey with itself infectious principles, but it aggravates cough

* Medical Sketches of the Campaigns of 1812, '13, and '14, etc. Dedham, (Mass.,) 1816, p. 240.

and complaints of the heart, which accompany the winter diseases on the northern frontier.

"These hospitals are more expensive than those built with framed timber and plank, excepting where the timber stands in the vicinity of the spot where erected. Upon a fair calculation made by the Assistant Quartermaster-General at Plattsburg, where it was necessary to draw the timber one mile, the expense of erecting log hospitals upon Dr. Tilton's plan was greater than with planked or boarded sides. The consequence was, the Quartermaster-General absolutely refused to give his assistance to erect them upon the plan proposed by the Surgeon-General. The experiment to demonstrate their usefulness was but partial at French Mills, where the army remained only a short time. No other attempts were made within my knowledge to prove them excepting at Brownville, under the direction of Hospital Surgeon Blood, who it was said reported favorably of them."

It would be difficult to devise a more objectionable plan for hospitals than that proposed by Surgeon-General Tilton. A ground floor is, of all others, the worst, for the very reason that it absorbs readily the organic matters given off from the bodies of the inmates. Instances of its deleterious influence in this respect will be given hereafter.

Dr. Mann's own ideas of a hospital will be perceived from the following extracts: "The wards of a military hospital should have an east and west aspect, with windows on each side. On the west a closed passage should extend the length of the hospital, 12 feet wide, into which the doors of the several wards open. The passage should be furnished with windows which correspond with those of the wards. This passage will be commodious for the patients able to walk, where they will be secure from cold and wet. In front of this should be an open piazza, projecting 10 feet, where the patients may walk unexposed to

the rays of the sun in hot weather. By means of two walls and the roof of the piazza heat will be excluded the rooms, which is at its highest in hot seasons after the sun has passed the meridian. These walls will also secure the wards from cold during the severe frosts of winter.

"Wards of an extensive hospital should be 30 feet by 24 in dimensions, and not less than 11 in height, which may accommodate 20 patients if not sick with contagious diseases. This number in a ward requires only two nurses when their diet is prepared in kitchens. The wards of Burlington Hospital (which had the reputation of being under the best regulations of any in the northern district) are 25 feet by 20, and 9 feet high. These rooms were found by experience to be too low. The windows of the wards should be constructed so that the upper sash may fall and the under rise at pleasure, that when ventilating them the air may have free access to the rooms without passing in currents immediately over the beds of the sick."

In wards of the size recommended by Dr. Mann, each of the 20 patients would have 36 square feet of surface and 396 cubic feet of space, less than half they now receive in the most crowded of our military hospitals. The wards are also badly arranged, as they appear to join each other, and the windows on one side open into a closed passage. No means of ventilation, other than the windows and fireplaces, were provided. The rules which were in force relative to the management of the Burlington Hospital, which for a time was under Dr. Mann's charge, were very excellent.

During the Mexican war no hospitals were constructed. The sick who were invalided went to the general hospital at New Orleans barracks, or to the barracks at Pascagoula. In Mexico, churches, convents, and other public buildings were made use of.

In the various Indian wars in which the country has been engaged the temporary hospitals erected have been of

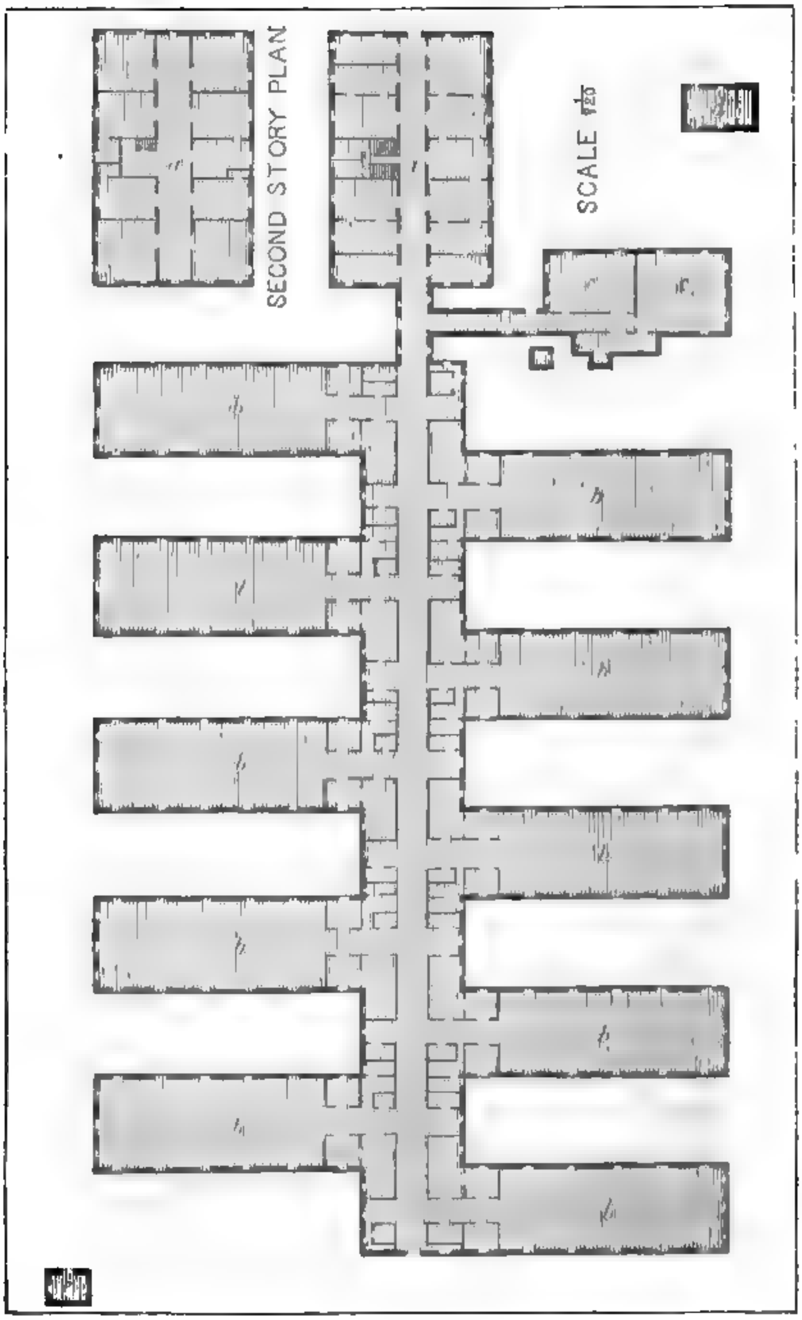
the most elementary character. This has in the main been due to the peculiar circumstances in which the forces were placed, preventing facilities for obtaining proper materials to be used in the construction and fitting up of hospitals. Generally they have been built of logs. In New Mexico, adobes (sun-dried brick) have been usually employed. Hospitals built of this material, though warm in winter and cool in summer through the thickness of their walls, are unhealthy, on account of the earthy walls absorbing the effluvia from the inmates. I have seen several cases of pyemia in such hospitals, which I am satisfied were due to this cause.

Owing to the large army maintained by the United States for the purpose of crushing the rebellion, many temporary hospitals became necessary. At first very little attention was paid to the planning of these structures; but as the wants of the army for hospital accommodation increased, more care and study were given to the subject of providing the means for sheltering the sick and wounded of the army.

The first pavilion hospital with ridge ventilation was constructed at Parkersburg, in the Department of Western Virginia. It consisted of an administrative building and two detached pavilions. It was planned by Assistant Surgeon Dunster, United States Army, from data which I gave to him as the result of the experience of the British Army in the Crimea. Another was soon afterward built at Grafton in the same department.

Two larger and more complete structures, planned by the Sanitary Commission, were about the same time commenced in Washington City. The ground-plan of one of these, the Judiciary Square Hospital, is represented in the accompanying cut, (Fig. 46:) *a a*, administrative department; *b b*, wards; *c c*, kitchens; *d*, guard-house; *e*, dead-house. The other, situated at Mount Pleasant, a short

Fig. 46.



JUDICIARY SQUARE ARMY GENERAL HOSPITAL.

distance beyond the city limits, is of like plan. The arrangement of the pavilions is similar to that followed in the Blackburn Hospital, (Fig. 34,) the administrative building being placed at one end instead of in the center. This latter is two stories high, the ward pavilions being but one. The ventilation is by zinc pipes in the roof and by an upper row of windows, capable of being opened and closed by cords. The corridor is wide, and the wards of ample size. The original plan placed the water-closets at the distant extremities of the wards, but they were changed to the other end, against the advice of the Commission, on the score of less cost of construction. A worse arrangement could not possibly have been devised than that which now exists. It is even worse than that which prevails in the south wards of the West Philadelphia Hospital, to which allusion will presently be made.

Another objectionable feature in these hospitals is that the partitions separating the wards from the corridor do not extend to the peak of the roof. It is thus possible to throw a stone, for instance, from one ward into another, and thus all the advantages of the pavilion system are lost.

The buildings are well supplied with water, and are lighted with gas. They will accommodate 25 patients in each ward, with 1200 cubic feet of space to each, making a total of 250 to each hospital.

These were, however, comparatively small hospitals; larger ones soon became necessary.

On the 1st of May, 1862, a larger and more imposing structure was commenced in West Philadelphia. This hospital is located at the intersection of Forty-fourth and Spruce Streets, half a mile outside of the limits of the City of Philadelphia. It is built upon an eminence, about two hundred feet above the bed of Mill Creek, and distant from it two hundred and fifty feet. Its situation has been

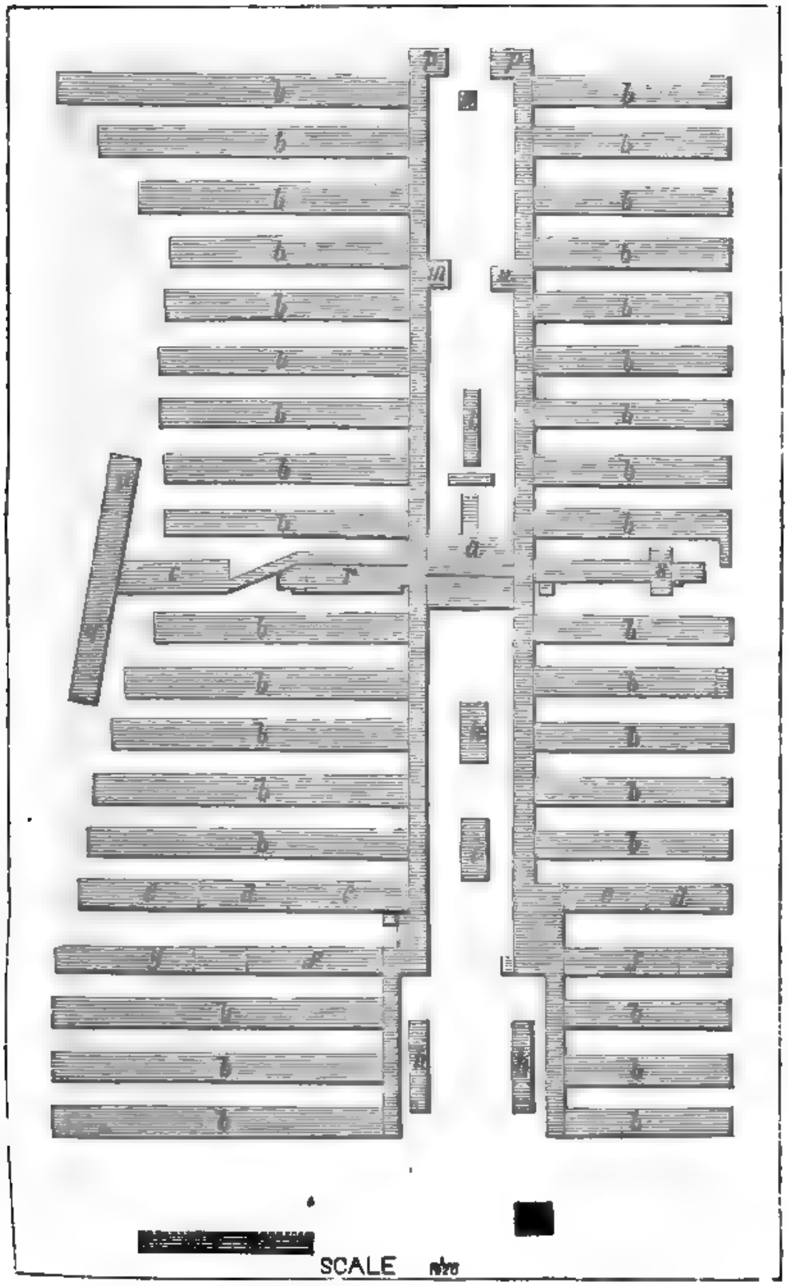
proven to be eminently healthy. The West Philadelphia Hospital is well and strongly built of wood, lathed and plastered on the outside. Its entire cost, exclusive of the furniture, exceeds 200,000 dollars. Two corridors, originally each 740 feet in length, are connected with a central administrative building two stories high. This building is 71 feet in width and 63 deep. The lower floor has a hall running through it into which seven rooms open. These are the surgery, reception-room, officers' mess-room, and the several offices necessary for the transaction of the business of the hospital. On the second floor are twelve rooms, which are used as officers' quarters. Two other detached buildings, on the east side, are also appropriated to this purpose.

The corridors, which join the administrative building, are 71 feet apart. They are each 14 feet wide, 13 high, and, originally, 740 feet long. Latterly they have been extended, and are now 860 feet long. These and the pavilions are one story high. The corridors are used as mess-halls, and answer the purpose admirably, as the wards open directly into them.

The pavilions are 167 feet long, 24 feet wide, and 13 feet high at the eaves. The pitch of the roof is 6 feet, and hence the height of the wards to the ridge is 19 feet. They are not ceiled. The pavilions are twenty-one feet apart.

Originally the number of pavilions used as wards was twenty-eight, and they were of uniform length. Latterly the number has been increased to thirty-four, by the addition of six at the east end of the structure. The accompanying cut (Fig. 47) represents a ground-plan of the building as it now stands. The pavilions on the south side were all extended as far as the ground admitted, so that they are now of unequal lengths: *a*, administrative building; *b b*, ward pavilions; *c c*, kitchens; *d d*, laundries;

Fig. 47.



GROUND-PLAN OF WEST PHILADELPHIA HOSPITAL.

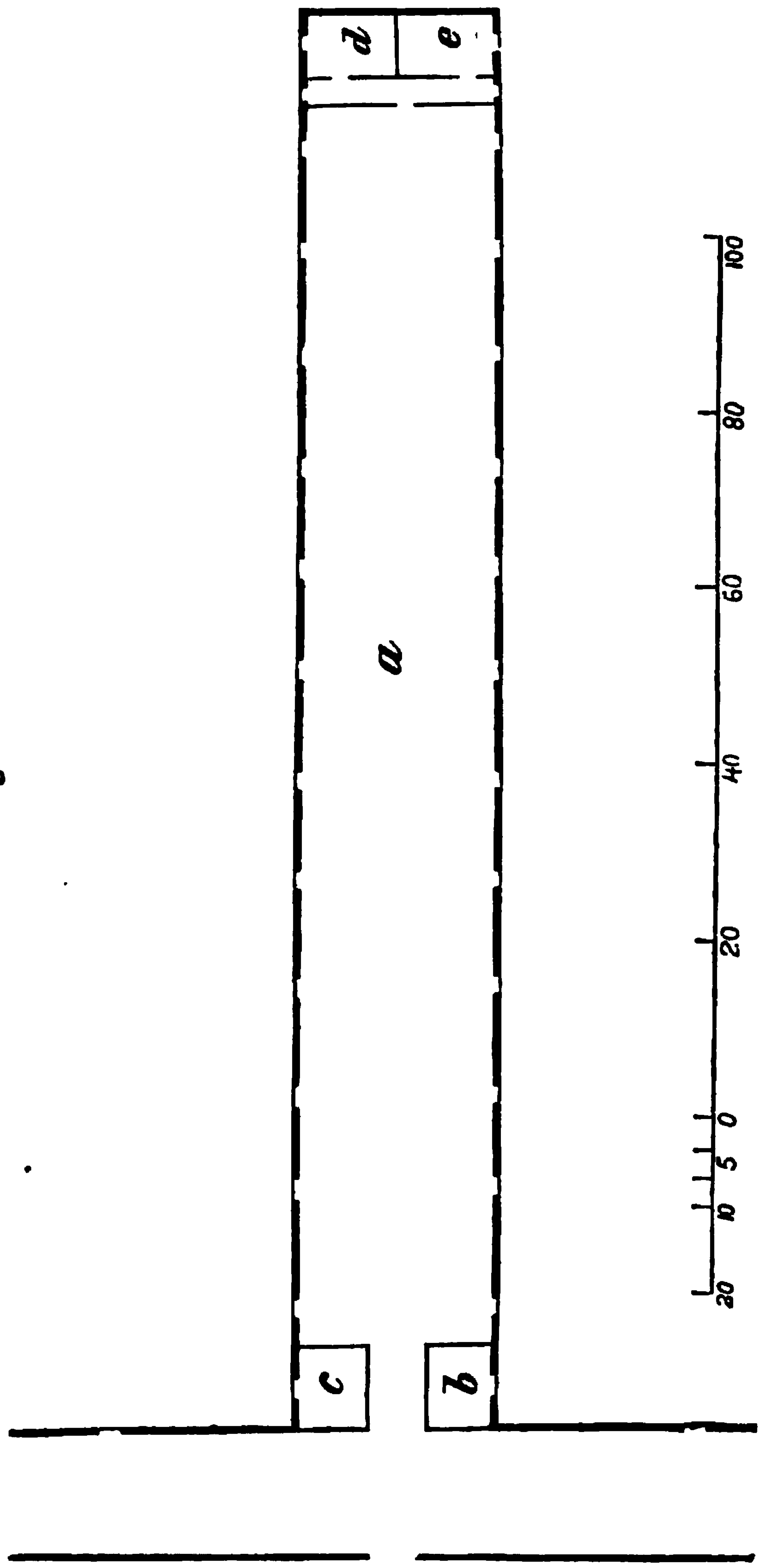
e, chapel; *f f*, store-rooms; *g*, mess-rooms, band, etc.; *h h*, officers' quarters; *i*, boiler-room; *k*, residence of surgeon in charge; *l*, water-tanks; *m*, barber-shop; *n*, printing-office; *o*, boiler and tank; *p p*, smoking-rooms; *q*, reading and lecture-room; *r*, knapsack-room; *s*, guard-room; *t*, stable; *u*, guard.

The wards upon the north side, with the exception of the three at the east end, are each 147 feet long, 20 feet being taken off for water-closet, bath-room, passage, ward-master's room, and sisters' room. The two latter are at the end joining the corridor; the water-closet and bath-room are at the distant end, and are separated from the ward by a passage three feet wide, running entirely across the pavilion. The water-closet is arranged with a cast-iron receiver or trough 12 feet long, 1 foot deep, and 1 foot 7 inches wide. It is kept partially filled with water from a pipe entering at one end, and the accumulations are drawn off at the other by means of another pipe emptying into the common sewer. Each bath-room is supplied with a cast-iron tray, over which water-pipes are laid, and in which the water-basins are placed and a cast-iron bath-tub, furnished with hot and cold water.

There are 24 windows in each of the original wards, 12 on a side. They are 6 feet 8 inches high, and 2 feet 7 inches in width. Between every two windows the beds are placed, so that the proper capacity of each ward is 48 beds. The superficial area of each of these wards (24 × 147) is 3428 square feet, equal to a little over 71 square feet to each bed. As the mean height of the ward is 16 feet, the total cubical contents are 54,848 feet, which affords an allowance of 1141 cubic feet of space to each bed. As the wards are well ventilated at the ridge, this quantity is amply sufficient to provide against overcrowding. The details of a pavilion are given in Fig. 48: *a*, ward; *b*, ward-

master's room; *c*, sisters' room; *d*, water-closet; *e*, bath-room.

Fig. 48.



DETAILS OF WARD PAVILION, WEST PHILADELPHIA HOSPITAL.

Hot water is distributed, by means of iron pipes, to all parts of the building, from an iron tank placed in each

kitchen. The water in the tank is supplied from the main, and is made hot by steam from the boiler in the front yard. The same boiler furnishes heat for the greater portion of the cooking that is done in both kitchens.

The arrangements for cooking in each kitchen are a large range, two large stoves, and three boilers, each holding 60 gallons.

The laundries are supplied with large cauldrons—the water of which is heated by steam—washing-machines, mangles, wringers, etc.

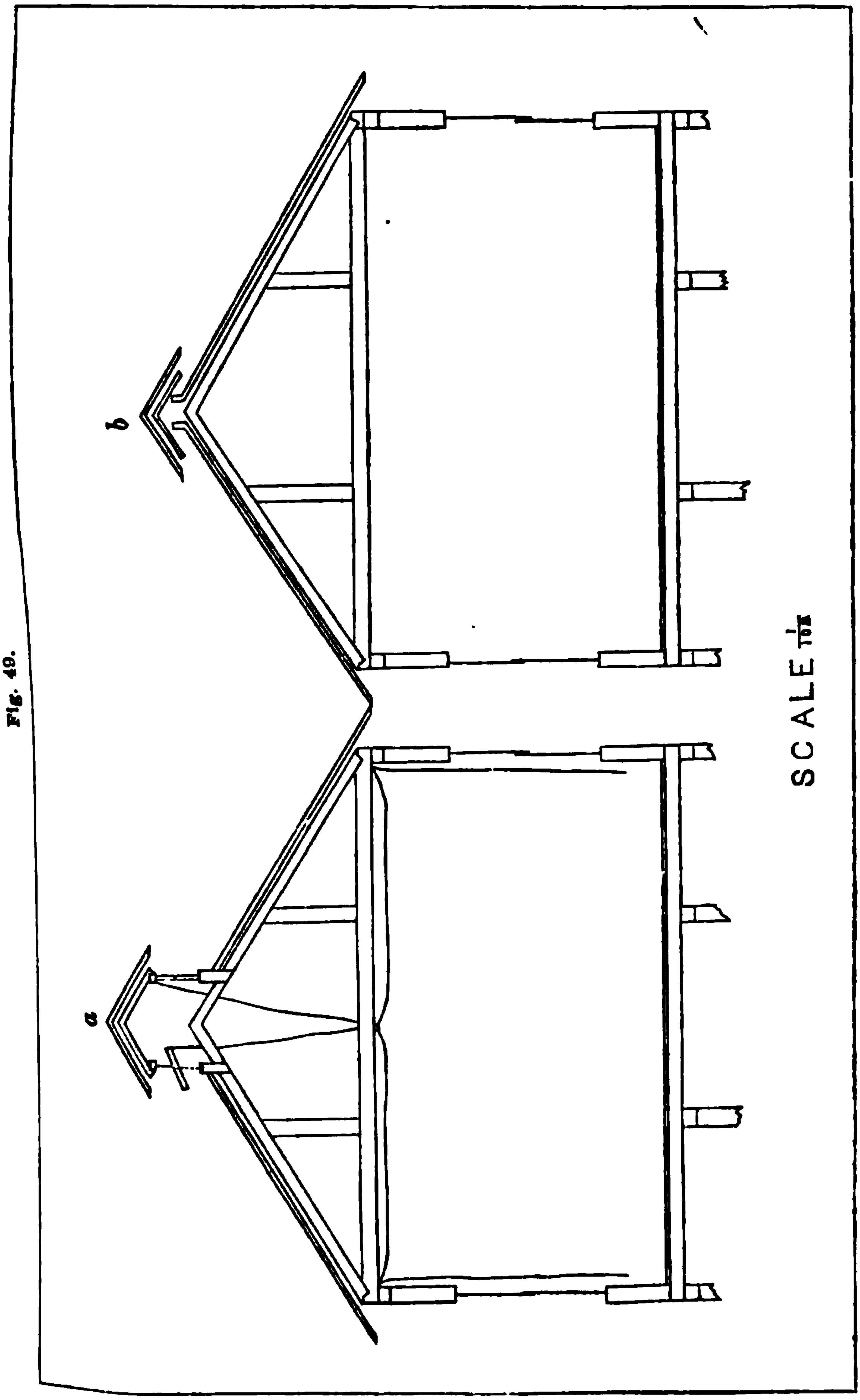
The wards are, as has been said, ventilated at the ridge. Twenty of them (the first built) by the method shown in section (in Fig. 49) *a*, and the remainder as shown at *b*. In the first the sides admit of being closed by means of cords acting on valves, but in practice this plan is not found to be so good as the other.

These ventilators extend the whole length of the ward. The opening in the roof is 1½ feet wide, the elevation of the ventilator above the roof of the ward 8 inches, and the width of the roof of the ventilator 3 feet 6 inches on each side. The first-named ventilators do not extend the entire length of the wards, being but 136 feet long. The height above the roof is 3 feet 6 inches, and the width (corresponding to the opening in the roof) 3 feet 11 inches.

The sewerage of the hospital is good. Two ten-inch earthenware pipes, laid in the ground too deeply to be affected by the frost, run along the ends of the wards, and receive the pipes from the bath-rooms, water-closets, laundries, kitchens, etc. They unite at the east end of the hospital and empty into a twelve-inch pipe, which leads into a sink, from which the fluid drainage is carried off into Mill Creek. This sink is arched over, and is one hundred yards from the hospital.

The supply of water is sufficient, and is derived from the Schuylkill River through the West Philadelphia

Fig. 49.



SECTIONS OF WARDS, WEST PHILADELPHIA HOSPITAL.

works. To provide against all possible contingencies, three tanks, holding over 75,000 gallons, have been erected. Ample provision against fire is made through numerous plugs and sections of hose in the corridors.

The original capacity of this hospital was 1344 beds, the 28 wards containing 48 beds each. But during the active campaigns of the summer and autumn of 1862 it became necessary to provide for a large additional number of patients in this institution. This was done both by erecting a number of hospital tents and putting up more beds in the wards. As soon as possible these latter were taken out, and to provide for those in tents, at the approach of winter, the wards of the south side were extended, according as the ground permitted, and six additional wards were built. By the extension of the pavilions, the water-closets on that side were thrown entirely within the wards, a result which is certainly to be condemned on hygienic grounds, and which will probably lead to serious inconvenience during warm weather if the additions are used for patients. It will be better therefore not to occupy the extensions as wards during the summer months.

At present the full capacity of the West Philadelphia Hospital is 3124 beds. It is the largest in the United States with one exception, (Chestnut Hill,) and with that exception the largest in the world intended solely for sick and wounded persons. Since its organization, and indeed since the work was commenced on it, it has been under the charge of Surgeon I. I. Hayes, United States Volunteers, and to his excellent management is mainly due the capital hygienic condition in which it has always been found. All the advantages of the building have been brought out, and every measure taken to lessen the evils which were liable to result from its objectionable features, with the one exception of extending the wards so as to change the relative position of the water-closets.

The West Philadelphia Hospital is by no means a perfect structure. The corridors are too close together, and the distance between the pavilions should be at least ten feet greater than at present. The water-closets are constructed after a bad plan, and though the trough may be regularly emptied every hour, the excreta remain in it that long, and render the air of the wards more or less impure. The extension of the pavilions on the south side has added to the evil. Wards have thus been constructed, which, as they now stand, are in opposition to the plainest teachings of sanitary science. Either the water-closets should be placed in the distant end of the wards on the south side, or the new parts of these wards should be emptied of patients as soon as warm weather sets in. One or the other of these measures will be carried out. The difficulties in the way of moving the water-closets were great, as the main sewerage pipe on that side passed immediately under them, and could not have been removed without an expense not thought justifiable at that time.

In all other respects the West Philadelphia Hospital is a credit to the army. The discipline has always been excellent, and the patients have been well cared for. The difficulties to contend with in the management of so vast an institution as this can scarcely be conceived by those who have not personally visited it and studied the system by which it is governed. The number of medical officers is at present fifty-two, besides eighteen medical cadets. The cooks, nurses, and other attendants number four hundred and sixty-four. There are also three chaplains.

A printing-press belongs to the hospital, and a newspaper is regularly published once a week. A large library and reading-room is also not the least of the hygienic advantages.

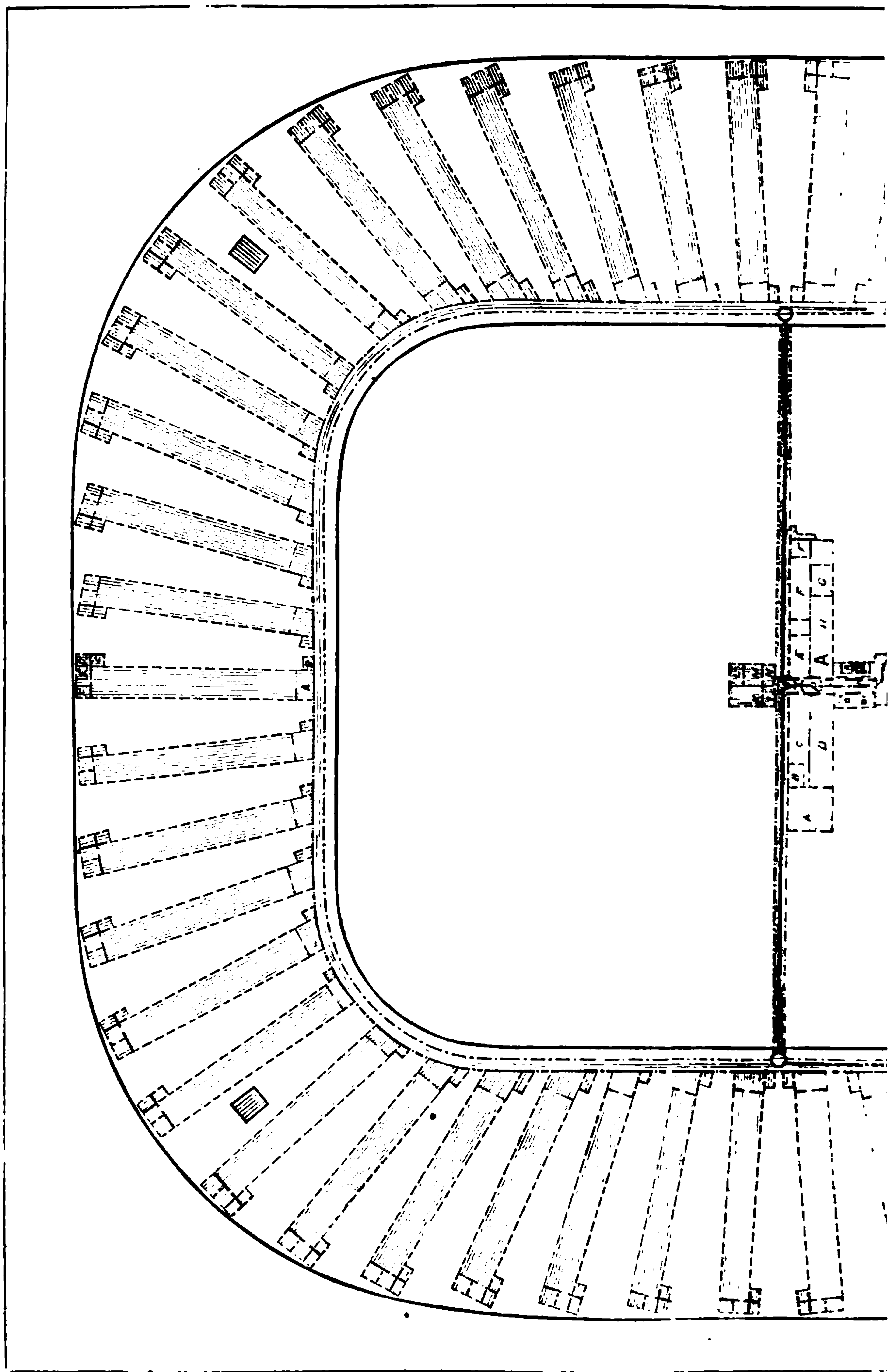
The largest and most complete military hospital in the United States is the Mower General Hospital at Chestnut

Hill, within the city limits of Philadelphia, but situated in one of the rural districts, away from the confusion and bad air of the thickly settled parts of the city.

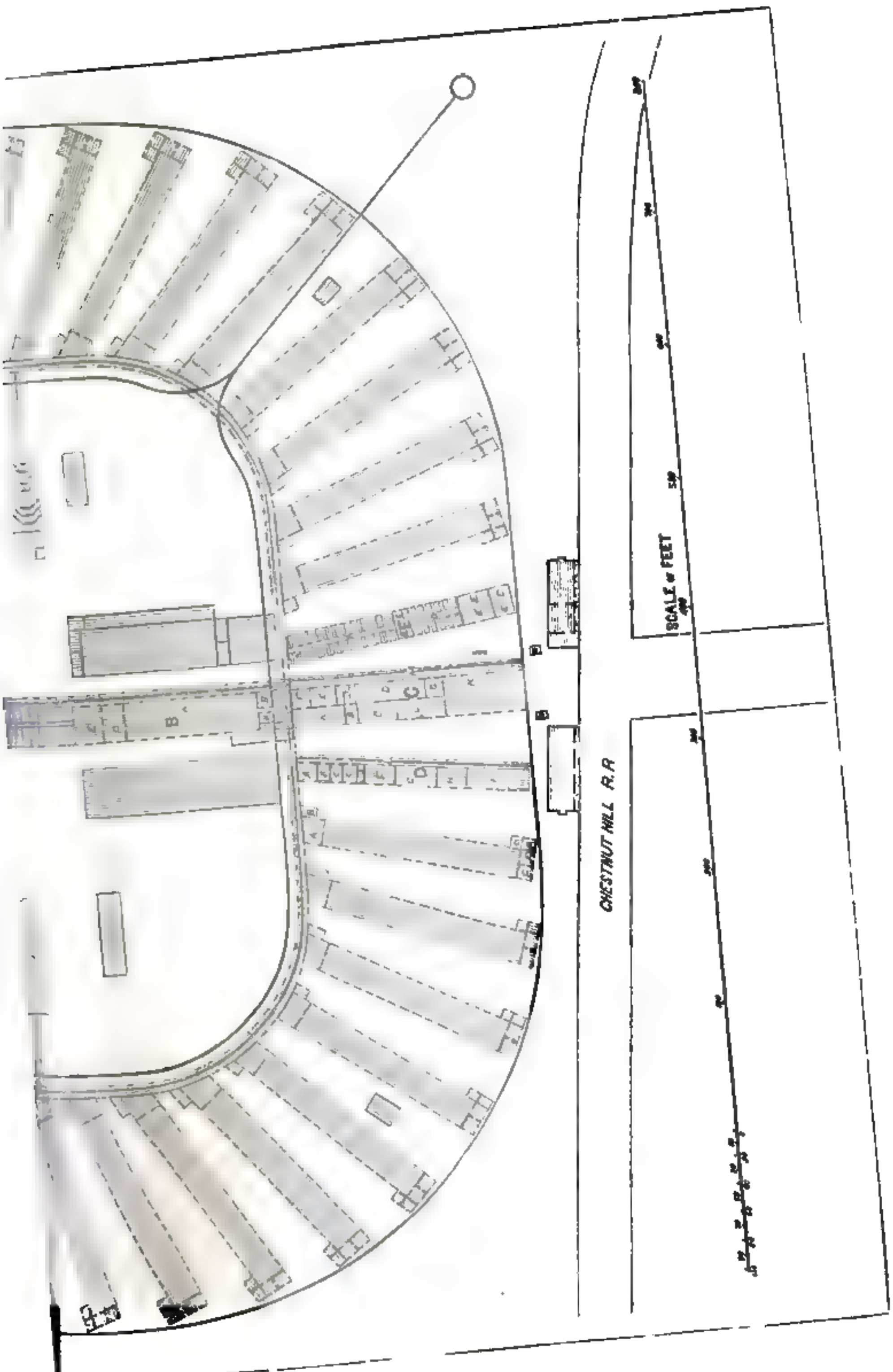
It is the largest institution in the world devoted to the reception of sick and wounded alone. The Salpetrière of Paris, though containing 4422 beds, cannot be considered a hospital in the strict sense of the word, as insane persons, idiots, and paupers constitute the bulk of its inmates; and the Bicêtre, with its 3118 beds, occupied in great part by the same classes, falls short in magnitude of the immense hospital at Chestnut Hill. Even the Grand Hospital of Milan, when filled to its utmost capacity, (2702 beds,) has 600 less than the institution under consideration. The Allgemeines Krankenhaus of Vienna, the largest hospital in Germany, contains about 2000 beds. The Chestnut Hill Hospital contains 2820 beds for patients, besides 500 for the officers, stewards, nurses, cooks, etc.

The Mower Hospital—so called after the late Dr. Mower, for many years the senior surgeon of the army, and beloved and respected by all who knew him—is situated on an elevated plateau, from which the drainage is excellent. It is constructed of wood in the best manner, lined with smooth planks on the inside and lathed and plastered on the outside. Its cost has been over 250,000 dollars, exclusive of the furniture. As a temporary hospital it has never been equaled in the completeness of all its arrangements, which have been carried out on a scale and with a thoroughness worthy of a permanent institution. It will last, without extraordinary repairs, for at least ten years. The Chestnut Hill and Philadelphia Railroad passes close to it, so that patients can be brought from the Army of the Potomac for instance, without the necessity of changing from the car in which they were originally placed.

Fig. 50 represents the ground-plan of the hospital at



MOWER GENERAL H



AL, CHESTNUT HILL.

Chestnut Hill. It is seen to be composed of 50 pavilions, projecting from a corridor of a flattened ellipsoidal form. This corridor is 16 feet wide and 2400 long. The ground inclosed by it measures 653 feet in its long diameter, and 522 feet from side to side; the area inclosed is therefore 341,466 square feet: *A*, indicates the building in which the principal offices are contained; *B*, kitchen and engine-room, etc.; *C*, barrack for band, nurses, and other attendants; *D*, provision store-rooms; *E*, barrack for guard, and knapsack-room.

The sides of the corridor are almost entirely composed of glàss set in sashes, which in summer are entirely removed. During inclement weather they are closed, and the corridor being furnished with fifty large stoves, an exercise hall, for those patients able to leave their wards, is thus at command.

The pavilions are arranged in radii, and are 20 feet apart at the corridor and 40 at the distant extremities. The circulation of the air around them is thus secured. The entire length of each pavilion is 175 feet, and the width—exclusive of the water-closet and scullery, which project from the pavilion—20 feet. The height to the eaves is 14 feet, and to the ridges 19 feet. The roof has thus a pitch of 5 feet. The length of the ward is 150 feet, the remaining 25 feet of the length of the pavilion being taken up by the mess-room at one end, the wash-room and wardmaster's-room at the other. As each ward contains 52 beds, there is an allowance of a fraction less than 60 square feet and 950 cubic feet to each patient when the ward is full.

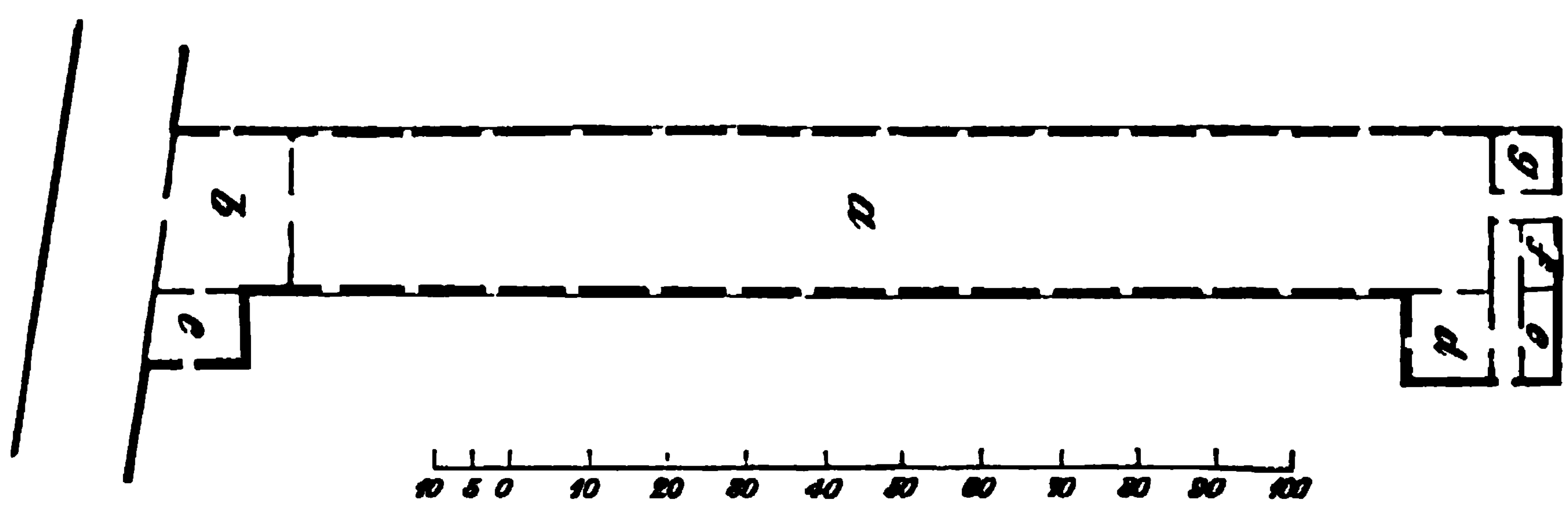
The water-closets are well arranged, the excreta being carried off at once by a full stream of water. The bath-room is furnished with a cast-iron bath-tub, to which hot and cold water are supplied. The ablution-room is also supplied with hot and cold water. The scullery, at

the other end of the ward but outside of it, is fitted with sinks, over which hot and cold water are laid.

To each ward at the end joining the corridor a mess-room is attached, sufficiently large for the use of those patients able to leave their beds. The food is brought to these rooms in hot-water cars running on a railway laid in the corridor throughout its entire length. By this means the meals are served hot from the kitchen, with which the railway is immediately connected. This railway also serves for the transportation of patients to their wards, and for carrying fuel, furniture, etc.

The details of a ward pavilion are shown in ground-plan in Fig. 51: *a*, ward; *b*, mess-room; *c*, scullery; *d*, bath-room; *e*, water-closet; *f*, ablution-room; *g*, wardmaster's-room.

Fig. 51.



GROUND-PLAN OF WARD PAVILION OF CHESTNUT HILL HOSPITAL.

The kitchen and laundry do not differ in their arrangements from those already described as existing in the West Philadelphia Hospital. Hot water from the large boilers is supplied to them by a steam-engine, which also forces it to the other parts of the hospital. Over 150,000 gallons of water are used daily, which is an average of about 50 gallons to each inmate.

The sewerage is very efficient. The administrative buildings and wards are all lighted with gas.

The *personnel* of the hospital consists of 30 medical officers, 8 hospital stewards, 3 chaplains, and 495 cooks, nurses, and other attendants. There is besides a guard of 86 men.

The hospital was organized by Surgeon Jos. Hopkinson, United States Volunteers, under whose charge it is at present, (April, 1863,) and who, by his efficient and systematic exertions, has harmonized all the arrangements of the vast establishment.

It should be mentioned that a magnetic telegraph and fire-alarm apparatus connects all the wards and offices with the office of the surgeon in charge.

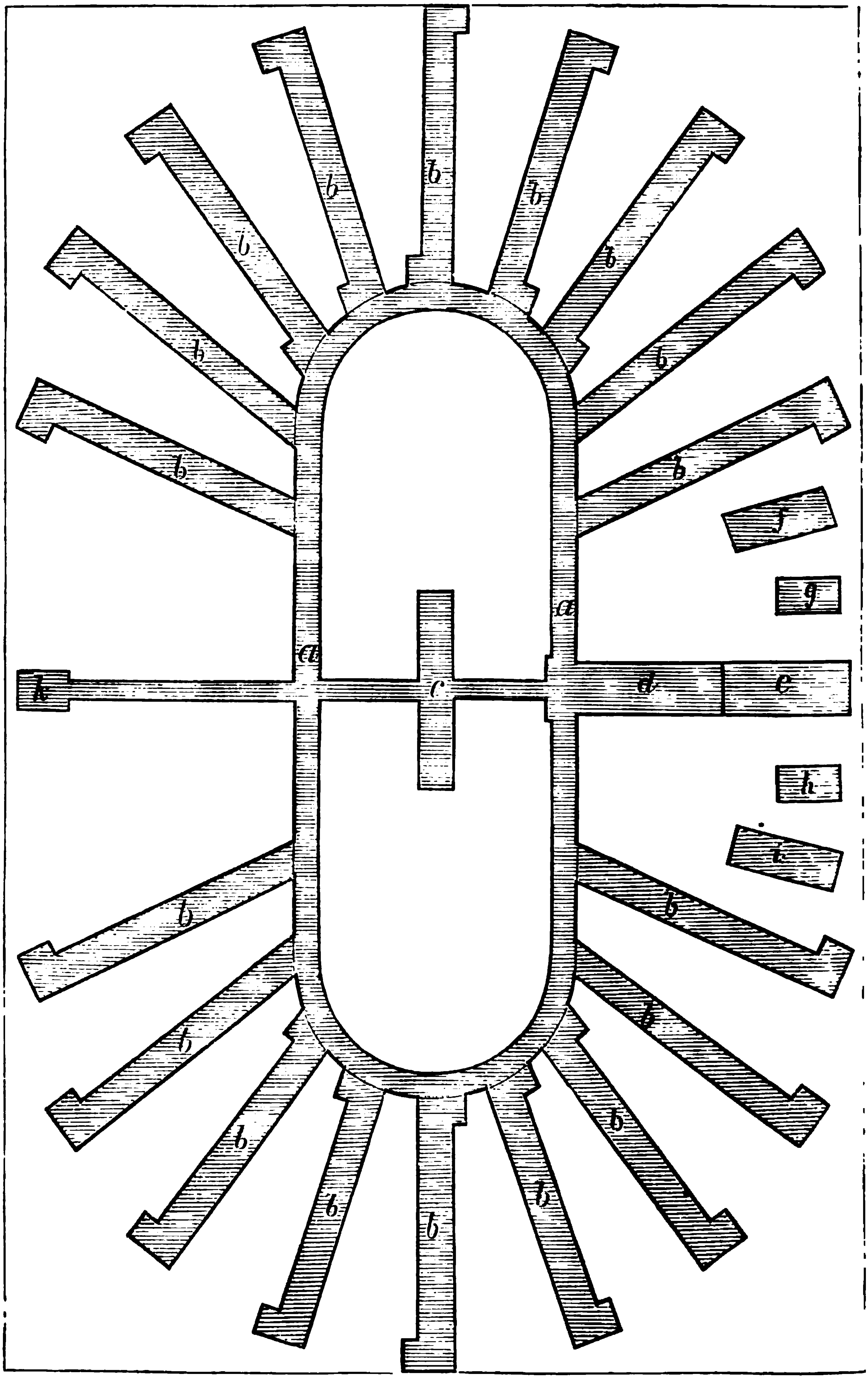
The only defect of any material consequence in the Chestnut Hill Hospital is the narrowness of the wards. They should be not less than four feet wider. Owing to this deficient width, the beds placed opposite the places occupied by the stoves must either be taken out, or turned with their length corresponding to the length of the ward, when the stoves are heated.

The ventilation is along the whole ridge in summer, and by the method already described for cold weather.

The ground inclosed by the hospital measures about seven acres, and affords ample space for an exercise ground for the patients. A healthier spot than the situation of the hospital is not to be found in the vicinity of Philadelphia.

Another very admirably planned hospital, and in some respects superior to that at Chestnut Hill, the McClellan, is also situated in the neighborhood of Philadelphia. The pavilions for wards are similar in general features, and are of the same size as those of the Chestnut Hill Hospital. The arrangement of them with reference to each other is somewhat different. A corridor of a flattened ovoidal form, inclosing a surface 550 feet long and 150 wide, connects the pavilions, which radiate from the opposite extremities only, instead of from the whole circumference, as in the

Fig. 52.



McCLELLAN HOSPITAL, PHILADELPHIA.

Chestnut Hill Hospital. The distance between the pavilions is greater than in the last-named hospital, and the whole system is less crowded. The administrative building is in the center, being connected with the main corridor by two straight passage-ways. All these corridors are open in summer. The kitchen and other offices are on the outside. Fig. 52 represents the ground-plan of this hospital: *a*, the main corridor; *b b*, wards; *c*, administrative building, which is two stories high; *d*, kitchen; *e*, laundry; *f*, clothing and guard-rooms; *g*, engine-room; *h*, stable; *i*, provision and knapsack store-room; *k*, quarters of medical officer in charge.

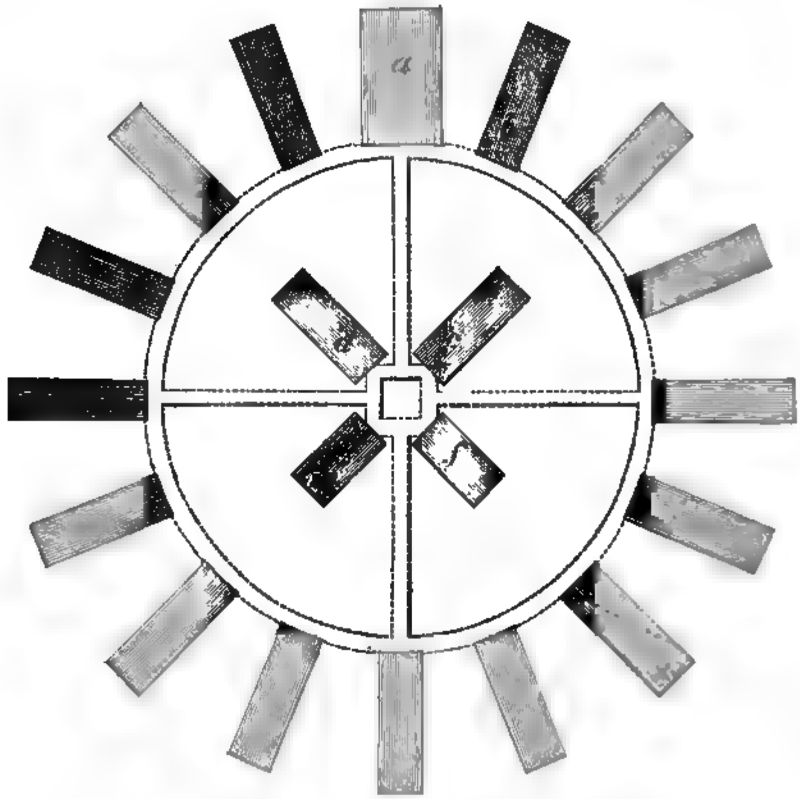
This hospital has 1040 beds—52 in each ward. Like the Chestnut Hill Hospital, it is supplied with water and gas, and has an efficient system of drainage. A steam-engine forces hot water from a boiler to all parts of the hospital.

The Hammond Hospital at Point Lookout, at the junction of the Potomac River with Chesapeake Bay, is one of the best, in every respect, belonging to the army. The situation of this hospital is such that the patients have the advantages of salt-water bathing and sea air. It is remarkably salubrious.

The hospital consists of 16 pavilions projecting from a circular open corridor. The pavilions are each 145 feet in length by 25 in width, 14 feet high at the eaves, and 18 at the ridge. They are built of wood in a substantial manner; are plastered inside but unceiled. They are ventilated throughout their entire length at the ridge. Fig. 53 represents a ground-plan of this hospital: *a*, the administrative building; *b*, wards; *c*, kitchen; *d*, laundry; *e*, guard-house; *f*, knapsack-room; *g*, dead-house. Open corridors lead from opposite points of the circular corridor to the buildings in the center. Each ward has 24 windows, besides 2 side doors, and is capable of accommodating 52

patients. At one end is a mess-room, and at the other, the farther from the corridor, a bath-room, water-closet, and

Fig. 53.



GROUND-PLAN HAMMOND GENERAL HOSPITAL, POINT LOOKOUT.

nurses' room. The elevation and ground-plan of a ward are shown in Fig. 54; and in Fig. 55 a transverse section of a ward is given, *a*; *b* and *c* represent transverse sections of the straight and circular corridors, and *d* a side view of a portion of the latter. The length of the circular corridor is 1001 feet, and the diameter of the space inclosed 318 feet.

Each patient in a ward of this hospital has 70 square feet of surface and 1116 cubic feet of space. Considering

the excellent means for ventilation, the wards being 36 feet distant from each other at the circular corridor, and

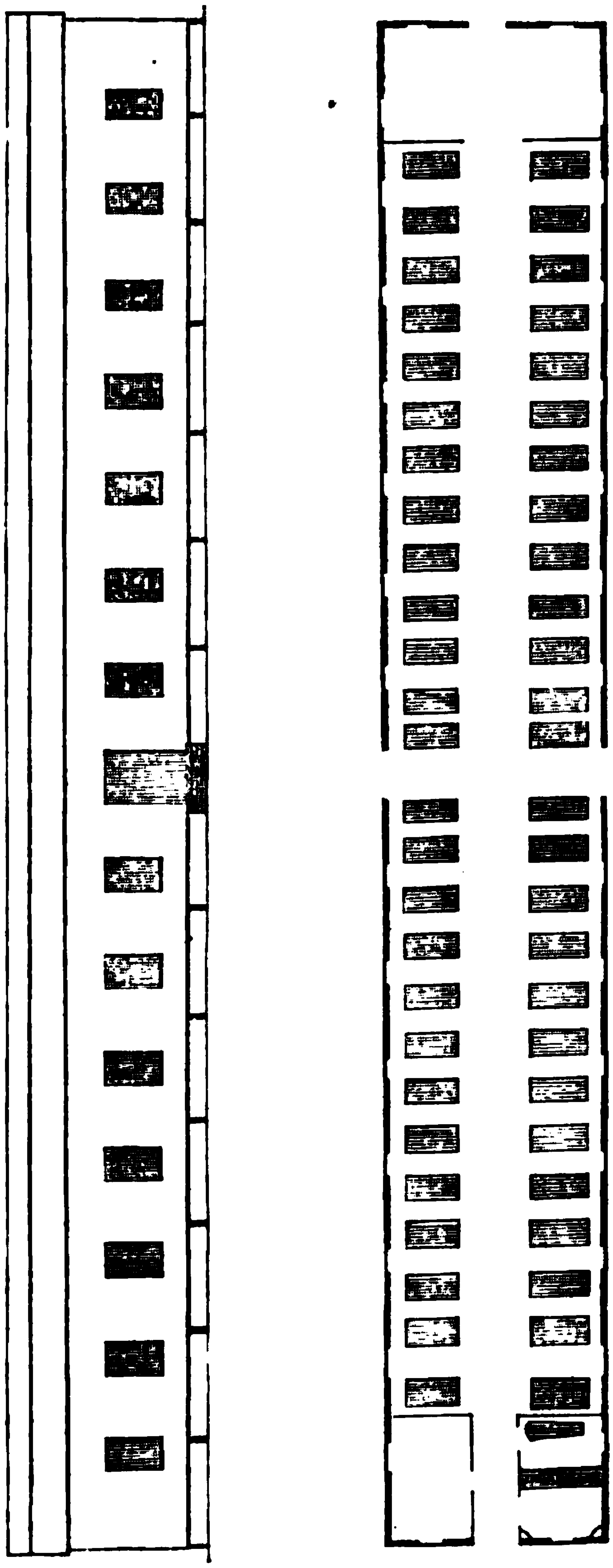


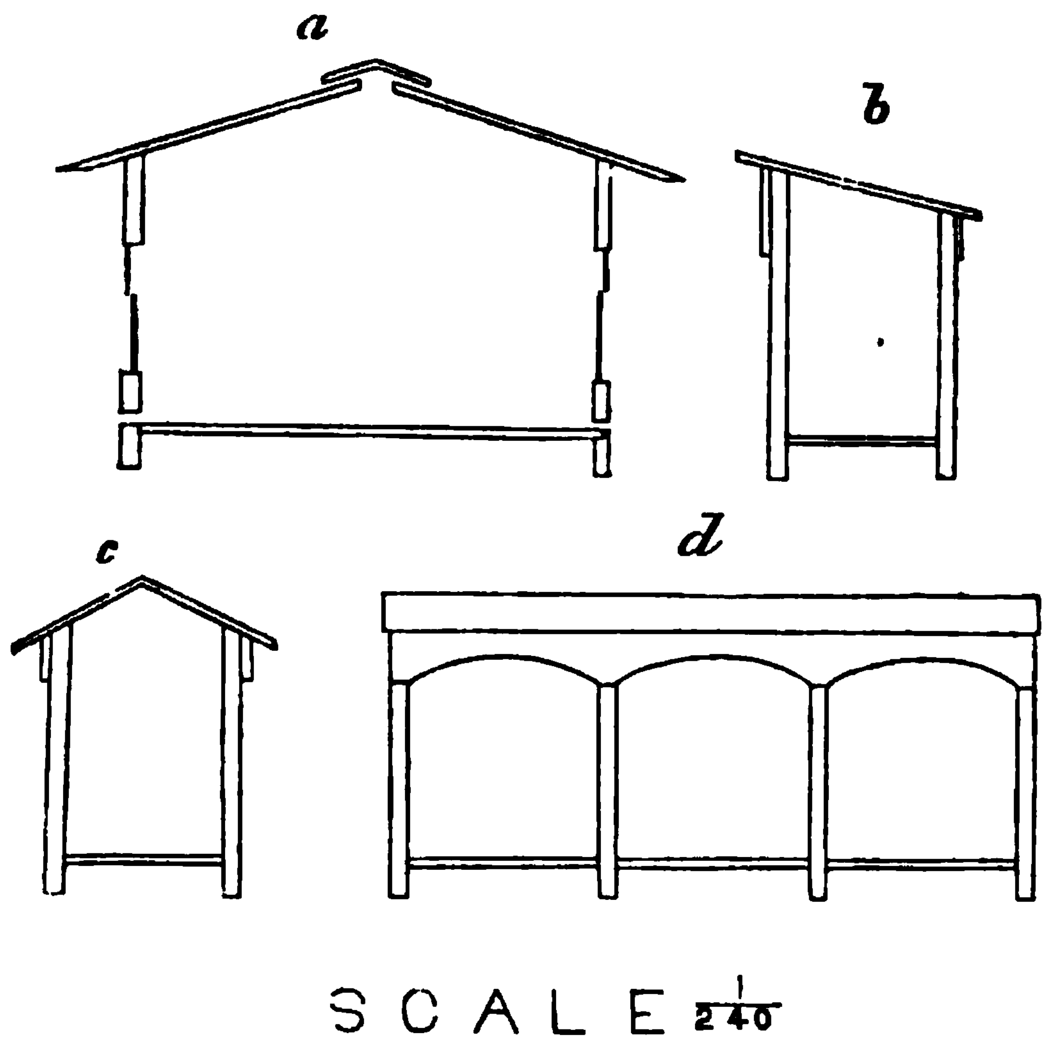
Fig. 54.

ELEVATION AND GROUND-PLAN OF A PAVILION OF THE GENERAL HOSPITAL AT POINT LOOKOUT.

75 at the other end, and the constant prevalence of a fresh pure breeze, this allowance may be considered

ample. Water is supplied from tanks which are filled from wells, and is heated by steam. The washing is done by machinery. The administrative building contains the various offices necessary for conducting the business of the hospital. Numerous cottages in the immediate vicinity of the hospital, and forming a part of its organization, are used as quarters for the officers and such of the attendants as can sleep outside of the hospital proper.

Fig. 55.



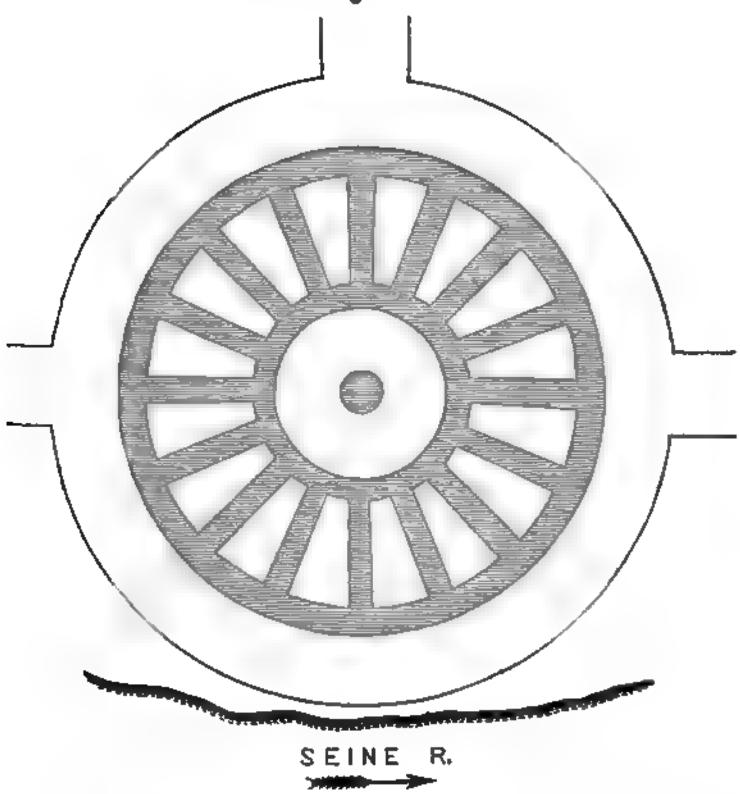
SECTIONS OF WARD AND CORRIDORS, POINT LOOKOUT HOSPITAL.

As there are 15 wards, of 52 beds each, the capacity of this hospital is 780 beds. Since its organization it has been under the charge of Assistant Surgeon Clinton Wagner, United States Army, who has, by his excellent management, made it a credit to the service.

The hotel and cottages—Point Lookout, previous to the rebellion, having been a watering-place of some importance—are also used for the accommodation of patients, making the entire capacity of the hospital 1700 beds. The number of medical officers at present is 14; medical cadet 1; hospital stewards 5; and nurses, cooks, etc. 192.

The plan of the hospital at Point Lookout presents several features of interest in a hygienic point of view. The peculiar arrangement of the wards allows of the freest circulation of air about them, and at the same time admits of the establishment being easily administered. There is the most complete isolation of the pavilions consistent with efficient administration.

Fig. 56.



POYET'S PLAN FOR HOSPITAL FOR 5000 PATIENTS. PARIS, 1786.

Among the plans submitted for the construction of a large hospital in Paris, after the burning of the Hôtel-Dieu, was one for 5000 beds by Poyet. A commission of the

Academy reported favorably in regard to this project,* but it was not adopted. A representation of this plan is given in Fig. 56. Its inferiority to that at Point Lookout is at once seen, though there is great similarity between the two.

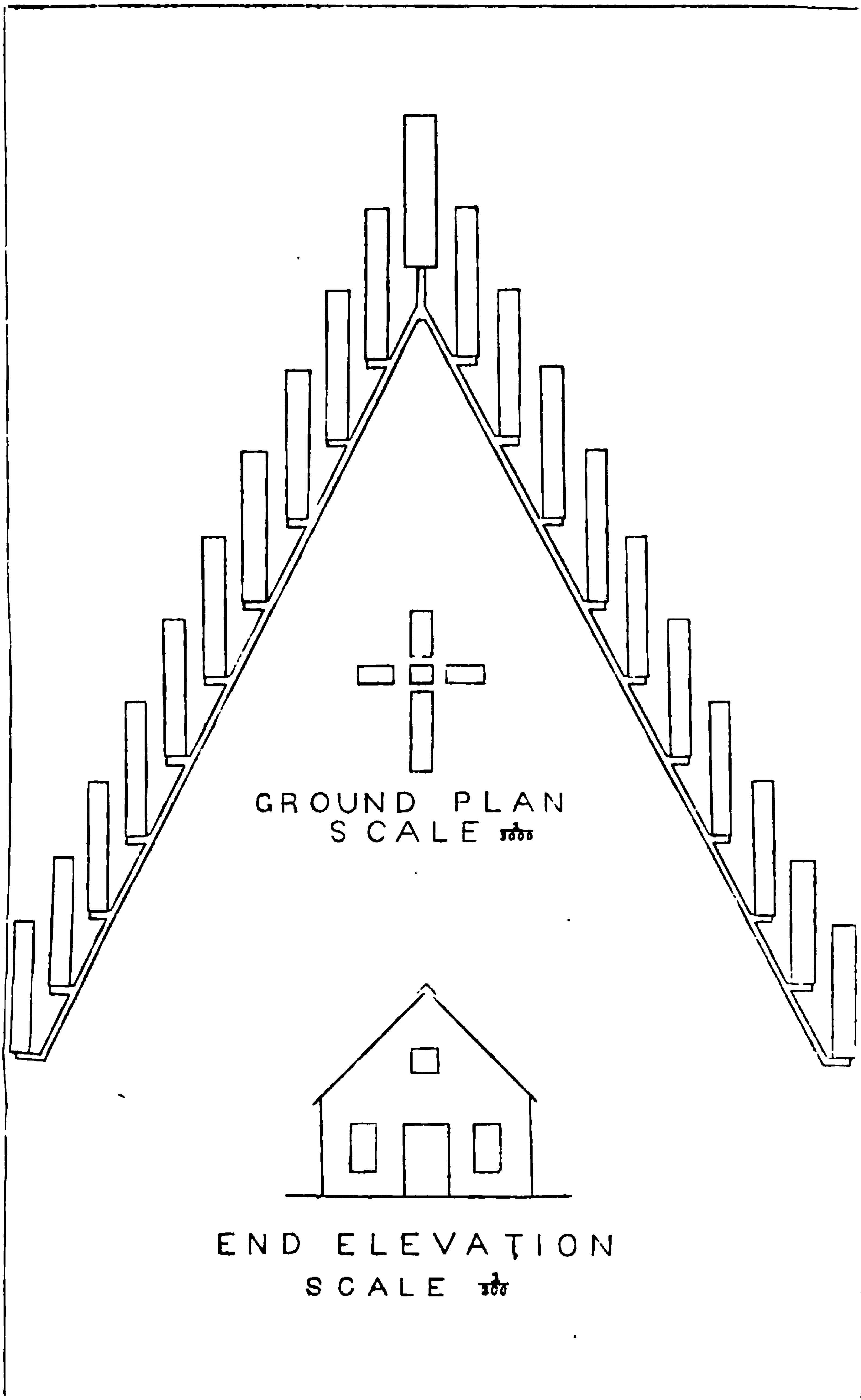
Several large hospitals have been constructed upon a plan which has many points to recommend it, though it is not so well adapted to this climate as that followed at Chestnut Hill and Point Lookout. Fig. 57, which represents the ground-plan and end elevation of a pavilion of the Lincoln Hospital in Washington City, is an illustration of the plan referred to. The arrangement is such that the pavilions are placed *en échelon*, and thorough ventilation is thus secured. The administrative building is at the apex of the hospital, and the kitchen, laundry, and other offices, in the center of the inclosure. A covered corridor, open at the sides, passes along each row of pavilions. This hospital accommodates 1200 patients. The pavilions are similar in their internal arrangements to those at Point Lookout.

The General Hospital at Hampton, near Fortress Monroe, is built after the same model, and is of the same size. That at Portsmouth Grove, Rhode Island, is composed of two such systems, the apices being close together, and the whole forming a figure resembling the letter ⋈. The only difficulty connected with plans of this kind for large hospitals is that of administration. In other respects no serious objection can be urged against them.

One other hospital belonging to the army deserves special mention, and that is the General Hospital at Fort Schuyler, near the entrance of the East River into Long Island Sound. The wards here are arranged tangential to an oblong corridor, open at the sides. This position of the

* Etude sur les Hôpitaux, etc., par M. Armand Husson. Paris, 1862, p. 29.

Fig. 57.



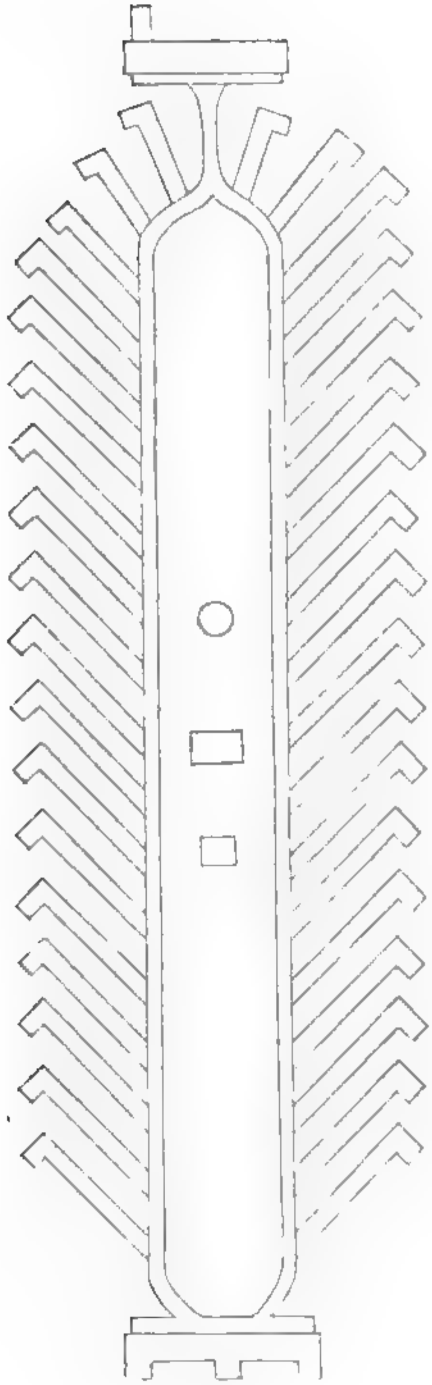
LINCOLN HOSPITAL, WASHINGTON CITY.

wards secures the free circulation around them of the air set in motion by the prevailing winds. The corridor is, like the Chestnut Hill Hospital, furnished with a railway by which the food, etc. are moved. The administrative building is at one end and the kitchen and laundry at the other. The wards are similar in their general features to those at the Chestnut Hill and McClellan hospitals, the water-closets and bath-room being entirely outside, at the distant ends. Each ward contains 48 beds except those at the end near the kitchen, which are but two-thirds the size of the others. The total capacity of the hospital is 1600 beds. Fig. 58 shows a ground-plan of the whole establishment. The hospital is situated on a narrow peninsula, and is almost entirely surrounded by salt water. The location is healthy, and is admirably adapted for the restoration to health of those invalid soldiers who have been broken down by service in malarious districts. It was organized by and is still under the superintendence of Assistant Surgeon Roberts Bartholow, United States Army. Its hygienic condition has always been excellent, and every comfort and convenience is provided for its inmates.

Several other very good plans have been followed in the erection of the large number of temporary hospitals which have been required. In all, the pavilion system of ridge ventilation has been enforced, except in one or two which were built without a reference of the plans to the Medical Bureau. Many of these, to which more specific reference cannot, for want of space, be made, are large, containing from 500 to 2500 beds, and are well arranged and conducted. A hospital, the duplicate of that at Chestnut Hill, is in course of erection at Louisville, Kentucky, and other large ones at Nashville, Tennessee, and at Madison, Evansville, and New Albany, Indiana.

In all these temporary hospitals particular attention has been paid to ventilation, to the avoidance of overcrowding,

Fig. 58.



GENERAL HOSPITAL AT FORT SCHUYLER.

and to supplying them with a sufficient amount of water. In all places where water could be introduced from mains it has been done, and provision made for heating it. When practicable, gas has always been used for lighting. The latrines have generally been of the most approved forms, and the drainage efficient. The kitchens are large, and, with the laundries, are furnished with every requisite convenience. In many of the hospitals steam is used for cooking and for heating water for washing.

The wards are furnished with iron bedsteads, and generally with hair mattresses. In some hospitals bed-sacks filled with straw are preferred, on account of the facility with which they can be removed. Hair is in all cases supplied for the very sick. The objections to straw beds are, that they become in a short time inelastic, and that they abstract the heat too rapidly from the body. Hair is undoubtedly preferable. Curtains to the beds are not used; they are objectionable on account of the facility with which they retain the exhalations of the patients. The French still retain them.

Cotton sheets are, on some accounts, preferable to linen for sick persons. They are warmer, and in cold weather this is a point of some importance. Linen is, however, in more general use.

The pillows are always of hair, and are inclosed in linen pillow-cases.

Tables, chairs, trays, and other necessary articles of hospital furniture for the wards, kitchens, and mess-rooms, are supplied in requisite quantities.

The subject of the food of the sick will be considered under another head. In the mean time, the principles which should govern in the construction of field and other more temporary hospitals than those which have been brought under notice in the present chapter, require attention.

CHAPTER XV.

FIELD HOSPITALS.

It often becomes necessary to establish field hospitals with great promptness, and therefore it is at such times impossible to comply with all the conditions which a regard for the health and comfort of the sick and wounded dictates. Barns, dwelling-houses, and other buildings in the vicinity of a field of battle are appropriated and fitted up as hospitals, with such conveniences as may be at hand. It is of course out of the question for an army in the field to carry with it bedsteads, mattresses, and other bedding, except blankets; and even cooking utensils, besides those contained in the hospital mess-chests, must be left in the rear; but with plenty of straw, a few tins, and the essence of beef, condensed milk, and coffee, and other hospital stores, which, if an army is victorious, can generally be brought up, the sick and wounded can be placed in a condition of comparative comfort.

Tent Hospitals.—The best field hospitals, both for summer and winter, are tents. Even in the coldest weather these can be made exceedingly comfortable by the small camp-stoves which are issued. After the battle of Antietam a field hospital was established at Smoketown, near the battle-field, under charge of Surgeon Vanderkieft, which may be considered a model for such establishments. Hundreds of wounded were treated at this hospital. It was kept in operation through the entire winter, and had at one time over one thousand wounded men in it.

In establishing field hospitals, one of the most important

points requiring attention is that of avoiding overcrowding. A regulation hospital tent should never be made to contain more than eight men as a maximum—six is a better number at all times. But it is sometimes impossible to regulate this matter according to the principles of sanitary science. The wounded must be provided for, and if there is a deficiency of hospital accommodation through any exigency of the service, overcrowding must be the consequence. The army hospital tent is fifteen feet square, is made of heavy duck, and is furnished with a fly. It is so made that two or more can be joined together, thus forming a tent ward: not more than three should ever be thus united. If it is probable that a field hospital thus constituted will be maintained for any considerable length of time, the tents should be floored.

A trench, eighteen inches deep, should be dug around each tent or set of tents. Nothing will justify the omission of this precaution. It is indispensable not only to the comfort of the inmates, but frequently to their lives. A drain must be made from the trench to allow the water to run off.

The nature of the ground upon which a tent hospital is established is of importance. It should be of such a character as to absorb moisture, and should have a gentle inclination. Sand and gravel in combination make the best soil.

The several details of the organization and management of field hospitals are matters of regulation, and do not come within the scope of this work.

The conical tent is not well adapted for hospital purposes. Having no perpendicular walls, ventilation cannot be effected, as in the hospital or wall tent, by raising the sides; moreover, in summer they are exceedingly hot, from this inability to cause a free circulation of air through them, and their not being supplied with flies to break the force of the sun's rays.

In order more effectually to ventilate the hospital tent, a slit should be cut in the end near the ridge, and kept open by a forked stick. The walls should be kept elevated during the greater part of the day when the weather will admit of it, and even in cold weather should be raised for a short time every day.

If the tents are not floored, they should be struck once a fortnight and the site changed, if only a few feet, should the condition of the patients not positively contraindicate it. The good effects of this measure can scarcely be overestimated. Fever cases, wounds, and most chronic diseases are invariably benefited thereby. The floors should be swept daily, and all accumulations of filth removed.

To repeat it, overcrowding is to be sedulously avoided. It is the greatest danger the surgeon has to guard against, and if he is obliged from necessity to put more men in a tent or building than is proper, no time should be lost in thinning them out. Dr. Mann* states that at Lewistown, during the late war with Great Britain, two barns, each forty feet square, were fitted up as hospitals. Floors of inch plank were laid on joists raised to a level with the sills of the barns. In each of these were placed one hundred men, but they were too much crowded. As soon as tents were furnished, more room was given by removing a part of the patients, so that sixty patients were comfortably accommodated in each barn. Dr. Mann says that these were the most comfortable summer hospitals which he saw during the campaign; and yet when they each contained one hundred men, the allowance of superficial area per patient was but sixteen square feet, so that the men must have been absolutely in contact; and even when the number of inmates was reduced to sixty, there were but a little over twenty-six square feet per man.

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* Op. cit., p. 249.

HUT HOSPITALS.—When there is a scarcity of tents, or if the weather is extraordinarily severe, it may become necessary to erect temporary huts or sheds to be used as hospitals. The same principles should prevail in such cases as govern the building of the general hospitals already described. Every possible comfort and convenience should be obtained. If this view is thoroughly acted on, it will be found that the sick and wounded can be remarkably well provided for even under very adverse circumstances. As huts are generally longer occupied than tents, it is proper to dwell with some detail upon the manner after which they should be built.

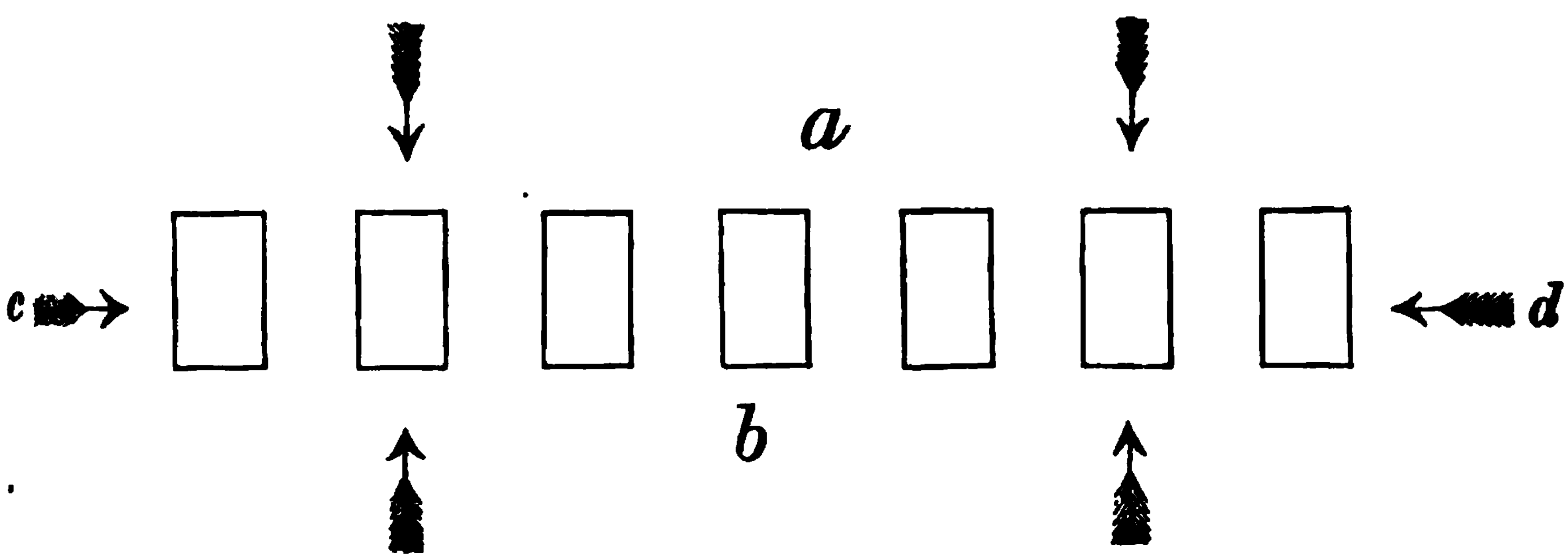
The sites should be such as to admit of easy drainage. A clay soil, which, as has already been shown, is powerfully retentive of moisture, should be, if possible, avoided, and one of sand, with a sub-soil of gravel, preferred. The ground should be slightly inclined, and, above all, should be well trenched, so as to avoid any possible accumulation of water. For obvious reasons, the huts should be placed in the vicinity of wood and water.

The huts should be separated from each other by an interval equal to twice the height of the huts, and should be so arranged that the air will circulate freely around them. They should not therefore be placed so that one can stand in the way of another receiving the beneficial effects of the wind, no matter from what quarter it shall blow. The ordinary way of placing them was, till recently, in a straight line, and this plan is still followed in arranging the tents or huts of the troops even in permanent camps. In camps formed by the troops when marching there is not so much objection to this plan, but if the stay is for several days it should be departed from. In Fig. 59 this arrangement is shown.

Huts or tents placed in this order are not thoroughly ventilated by the wind, unless it blows from the directions

a or *b*. When it comes from the points *c* or *d*, the bad air of the huts is carried along the line and accumulates the noxious effluvia in its passage.

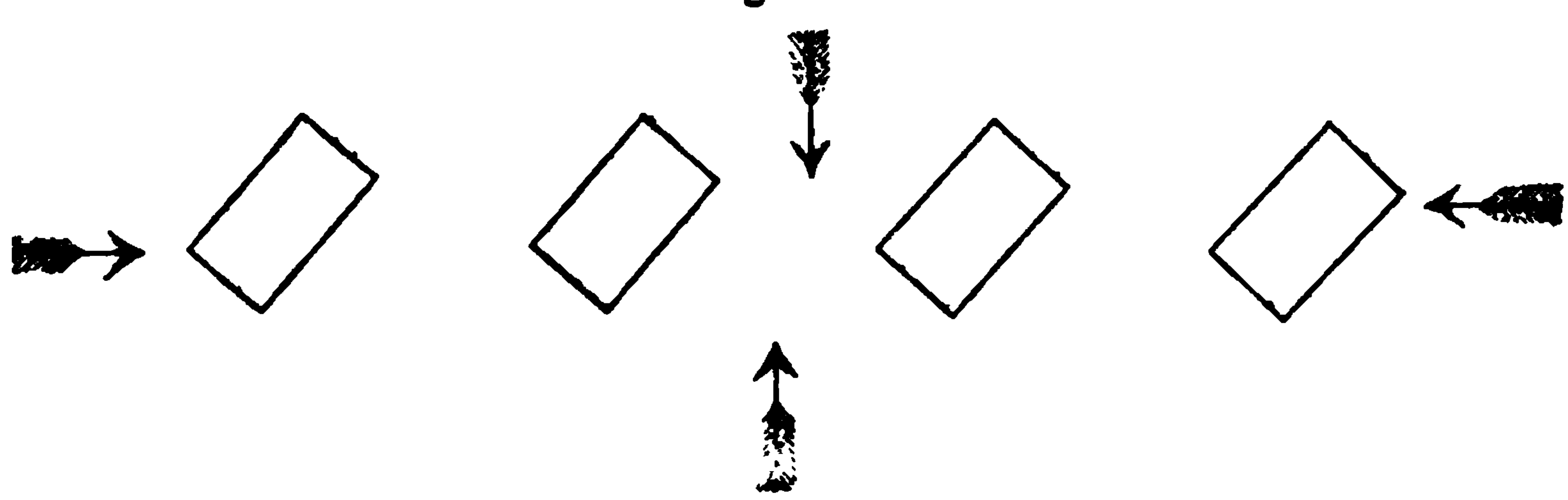
Fig. 59.



In some camps which I have examined I have found the tents or huts in actual contact—not in hospital camps, however, there being few medical officers so ignorant of their duty as to permit such a violation of the laws of health when in their power to follow the teachings of reason and experience.

The best of all arrangements for hospital tents or huts is that by which they are placed *en échelon*, as shown in the accompanying diagram, (Fig. 60.) Here the structures

Fig. 60.

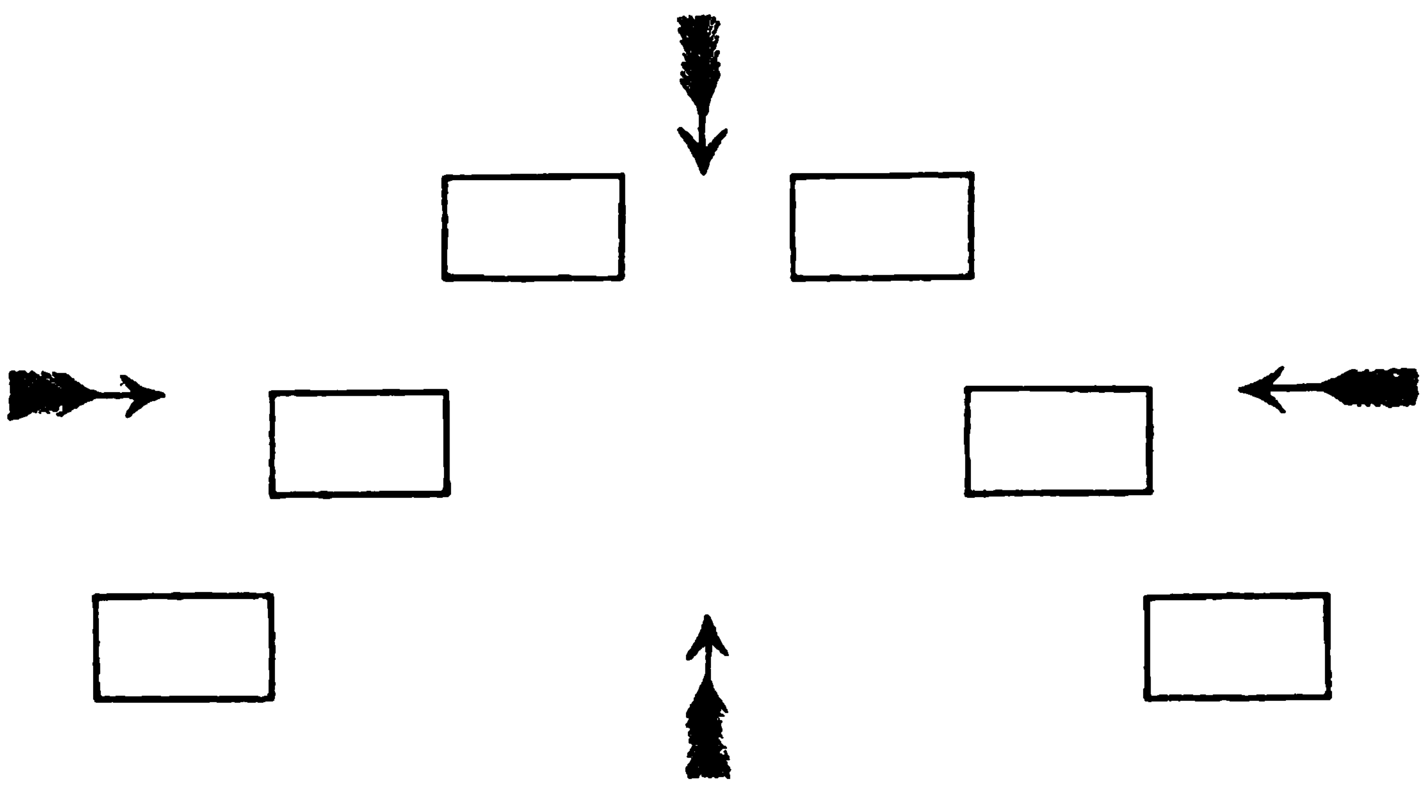


are not only placed so as not to obstruct the free circulation of the air about them, but the distance between any two is equal to twice the height, and consequently the

effluvia from any hut, even if a portion should be blown toward another, is so diluted as to lose the greater part, if not the whole, of its noxious character.

Several large hospitals have been constructed upon plans which are modifications of this and the following, (Fig. 61,)

Fig. 61.



which may be used when the ground will not admit of the prolongation of a single line of huts or tents; and they have been found to be exceedingly advantageous.

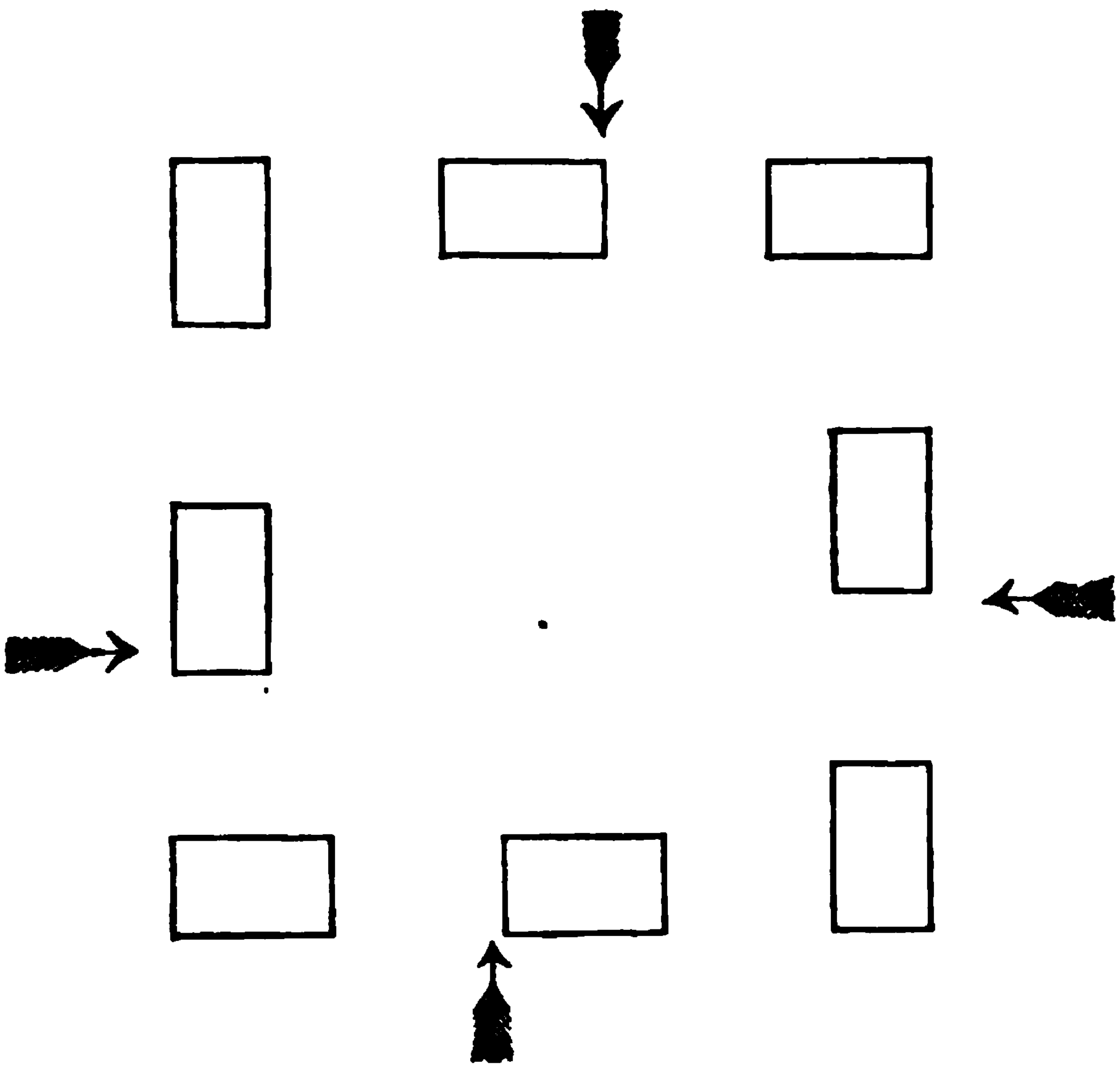
In Fig. 62 the huts or tents are arranged in the form of a square, and so that the air will sweep freely around each, no matter in which direction it blows.

In the erection of huts it is essential that the floors should be raised a foot or eighteen inches above the ground, and the space between the floor and the ground should be left open, so as to allow the air to circulate freely through it. In the Judiciary Square Hospital in Washington City a great mistake was committed in closing this space. It cannot too strongly be impressed upon the student of hygiene that confined air is always deleterious to those subjected to its influence.

In tents or huts the same allowance of space is not requisite as in permanent hospitals built of stone or brick.

In these latter, as we have seen, the amount should not be less than twelve hundred cubic feet and from eighty to one

Fig. 62.



hundred square feet, but in huts six hundred cubic feet and between fifty and sixty superficial feet will be found sufficient. This is the allowance recommended by General Burgoyne* of the British Army, Inspector-General of Fortifications, and doubtless his opinion was given after full consultation with, if not at the direct suggestion of, the medical authorities. A distance of at least five feet should intervene between the rows of beds, and the beds should be arranged in pairs, as in the hospitals already described.

If the huts are built of logs, they should be well chinked and plastered, and are much improved by the logs being squared on the inside. If scantling and boards are used, the walls and roofs should be lined, so as to leave an air

* Suggestions for the Construction of Wooden Huts for Barracks and Hospitals, and for the adaptation of Buildings for Barracks and Hospitals in the North American Provinces.

chamber of four inches between the outside and inside walls. Such was the form of hut used in the Crimea by the Naval Brigade, after the plan furnished by the Sanitary Commission sent to the East by the British government. In their report* the Commission state that, after selecting the site,—

"The ground was immediately cleared, leveled, and drained. A foundation of large, rough stones—picked off the adjacent surface—about a foot high, was formed, and the timbers and flooring of the huts laid on these stones. By this simple means the air was allowed to circulate freely under the hut, and all risk of damp was removed."

The sides and roof of each hut were double, and a current of air was allowed to pass upward in the space between the outer boarding and the inner lining, in the manner already mentioned. As the result of this arrangement, the temperature was the same inside the hut as it was outside in the shade.

"Ridge ventilation was introduced, and the external air was admitted a little above the level of the floor by simply raising the lower edge of one of the boards a little outward and one of the inner boards a little inward, to permit air to enter." The provisions for ventilating the wards and carrying off the hot air from the walls are shown in Fig. 63, which represents a transverse section of one of these huts.

The windows were swung on pivots, and on account of their small size were the most objectionable feature of the hut. A covered porch was erected at each end, and the eaves of the hut projected far enough to carry the water away from the foundation. This hut was considered by the Commission as a model for camp hospital purposes. It certainly is very admirably conceived, and has been used

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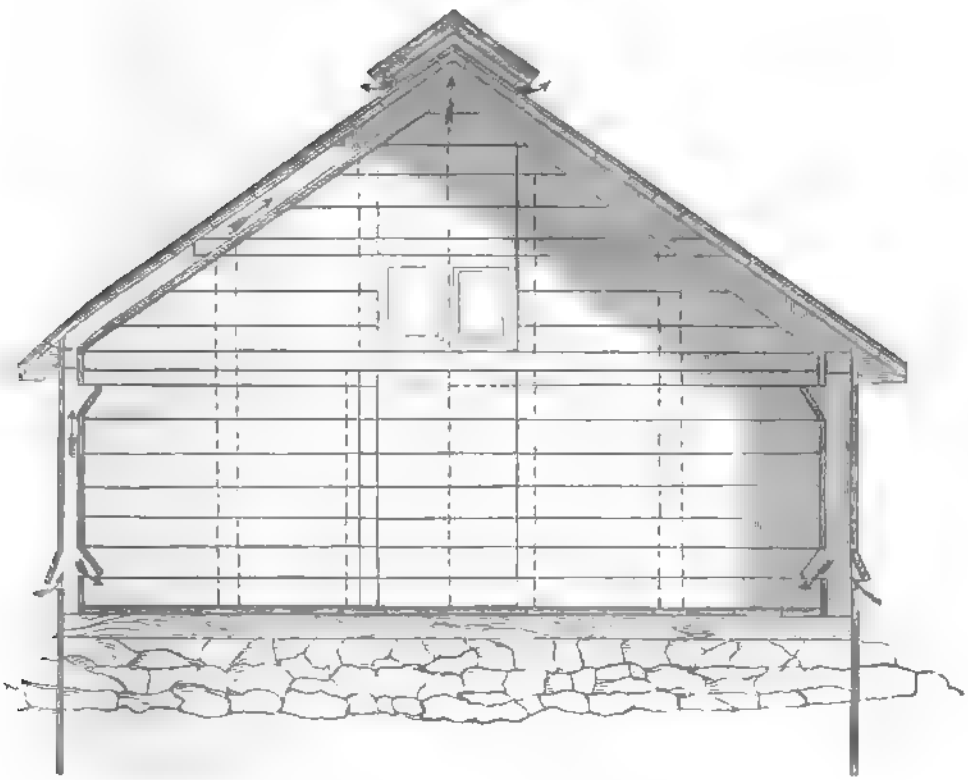
* Report to the Right Honorable Lord Panmure, G.C.B., etc., Minister at War, p. 142.

as a pattern for many that have been built during the present war.

Fig. 63.



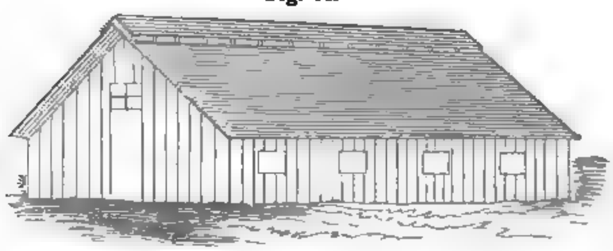
CRIMEAN HOSPITAL HUT, NAVAL BRIGADE.

If material is scarce, or if from other causes it is impracticable to have the huts built with double walls, the plan shown in Fig. 64 may be followed as the next best, the windows being made, if possible, double the length indicated. This figure also gives a good view of the ridge opened so as to allow of ventilation. A transverse section is shown in Fig. 65.

Huts were constructed in the Crimea with the sides banked up with earth, and often with no means, or very

imperfect arrangements, for ventilating at the ridge. There is a disposition in our own army to follow the same system, and there is reason to believe that it has been productive

Fig. 64.



RIDGE VENTILATED HUT.

of a good deal of sickness. This subject will more fully engage attention when we come to the consideration of barracks and camps.

Fig. 65.

RIDGE VENTILATED HUT—TRANSVERSE SECTION.

For heating huts, nothing is equal to the open fire-place, which, at the same time that it warms the hut, carries off through the chimney a portion of the foul air. Stoves, though they give out more heat, are less desirable on account of the sensation of closeness which they communicate to the air. If they are used, the floor should be opened under them, and air shafts, passing to the exterior on both sides of the hut, arranged after the plan already described.

In these temporary huts not more than twenty-five beds

should be placed. Huts well built, according to either of these plans, are far better, hygienically, than any permanent hospital of brick or stone ever erected.

So far we have considered the wards alone. The administrative building should be conveniently situated, and the kitchens should be close enough to admit of the meals being served hot to the patients. A mess-room for those able to leave the wards should be connected with the kitchen.

The camp hospital at New Creek, Virginia, which was calculated for about one thousand patients, was composed of two double *échelons*, the apices pointing toward each other. The administrative buildings were on the inside, and the latrines on the outside. Latrines should be dug at least some six or eight feet deep, and every day the accumulations should be covered with powdered charcoal and fresh earth. They should be situated as far as possible from the source of the water supply of the hospital, and should on no account be built over a stream of running water, for by such a course the water would be rendered unsuitable for those who might have to use it lower down the stream. They should be placed on that side of the hospital toward which the prevailing winds blow.

It will perhaps not be out of place again to insist upon the great advantages of these temporary field hospitals over those located in permanent buildings in towns. Nothing is better for the sick and wounded, winter and summer, than a tent or a ridge ventilated hut. The experience gained during the present war establishes this point beyond the possibility of a doubt. Cases of erysipelas or of hospital gangrene occurring in the old buildings—which were at one time unavoidably used as hospitals, but which are now almost altogether displaced for the ridge ventilated pavilions—immediately commenced to get well as soon as removed to the tents. But in one instance that

has come to my knowledge has hospital gangrene originated in a wooden pavilion hospital, and in no instance, so far as I am aware, in a tent. Hospital gangrene has been exceedingly rare in all our hospitals, but two or three hundred cases occurring among the many wounded, amounting to over one hundred thousand, of the loyal and rebel troops which have been treated in them.

Again, wounds heal much more rapidly in them, for the reason that the full benefit of the fresh air and the light are obtained. Even in fractures the beneficial effects are to be remarked.

Of course, to obtain the utmost degree of good from such hospitals, it is necessary, as in everything else, that the best medical officers should be placed in charge of them. Men who not only know their duty, but who are possessed of the requisite administrative ability to carry out the measures which their judgment dictates. Something more is needed than mere professional knowledge; an association with military men and the acquirement of the habit of commanding are indispensable. Some persons gain the power quickly, others never acquire it. It is an error therefore to suppose that because a medical man is a good practitioner or an accomplished teacher that he is at once qualified to assume the charge of a military hospital. Accustomed to practice in a city, with every convenience at hand, civil physicians and surgeons are often lost when they are thrown upon their own resources, and, knowing nothing of the exigencies of a military life, are indignant when the purveyors express themselves unable to comply with their demands. The business of a military surgeon must be learned like every other, but in times like the present the scholars are apt, and vie with each other in their efforts to render themselves useful to their country.

CHAPTER XVI.

LIGHTING OF HOSPITALS.

ALL means in use for the artificial illumination of buildings produce contamination of the atmosphere, through the evolution of deleterious substances, the result of combustion. It is important in all dwellings that these products should be removed, and it is especially so in hospitals, where many sick persons, themselves giving off noxious effluvia, are inmates of one room.

The substances employed to produce light in dwellings are solids, liquids, and gases. Under the first class are embraced candles of wax, spermaceti, stearine, paraffine, lard, and tallow; under the second, certain fish and other animal oils, vegetable oils, kerosene, naphtha, turpentine, and several mixtures of this substance and alcohol; under the third, the ordinary illuminating gas, composed mainly of carbon and hydrogen, and produced from the destructive distillation of coal, or resinous or fatty substances.

If the matter is regarded from an economical point of view, *wax candles* are the most expensive means of illumination; but if the subject is considered in its hygienic relations, they are to be preferred as the most healthy. In burning they produce very little smoke or heat, and the substances which arise from their combustion are not of the most injurious kinds—margaric and oleic acids, with a small quantity of carbonic acid, being the principal matters given off. Moreover, the light is neither intense nor of a character to be disagreeable to the patients of a hospital ward.

Stearine in burning produces carbonic acid, carburetted hydrogen, and pure carbon, which is given off in small flakes. Arsenic was at one time used in the manufacture of stearine candles to render them hard, and must necessarily have produced injurious results to those inhaling the fumes of the candles containing it.

Spermaceti gives an excellent light, and evolves no very injurious substances. The amount of carbon separated is small.

Tallow gives rise to a great deal of smoke, consisting principally of carbon in a solid form. A large amount of empyreumatic oil is also disseminated by its combustion. Tallow candles give a dull, unpleasant light, and are not fit to be used in rooms inhabited by the sick. The carbon and empyreumatic oil produce irritation of the respiratory passages. A great deal of the unpleasant effects of the combustion of tallow candles is due to the large size of the wicks, causing more tallow to be absorbed by them than can be perfectly consumed; the consequence is that incomplete combustion is the result, and the products escape in the surrounding air.

Paraffine affords an excellent light, and, if kept removed from currents of air, burns with a steady flame, and gives off very little smoke.

The *animal oils* give off, in burning, carbonic acid, carburetted hydrogen, and carbon. If the wicks, through which they are burned, are not well trimmed, or if the lamps are of a bad model, the amount of these emanations is very much increased. The *vegetable oils*, such as those from rapeseed, linseed, etc., burn with a brighter flame and give off less carbon. *Turpentine*, and its combination with *alcohol*, though giving a good light, are dangerous, and their vapor irritating to the respiratory passages; the same is true of *kerosene* and *naphtha*. Lamps are made which produce more complete combustion of oils than others, and

on that account are to be preferred. But, as a general principle, oils should not be used for lighting hospitals, on account of their greasy character and consequent liability to soil things with which they come in contact, and also because lamps require more care than the other means of illumination. Turpentine and the mineral oils should never be employed; they are the most deleterious of all the several articles which are ordinarily used for producing light.

The most economical substance for effecting artificial illumination is *gas*, both as regards the quantity of light obtained and the absolute cost. It is also convenient, and requires no labor, from the attendants of a hospital, in preparation.

Illuminating gas is composed of carbon and hydrogen, in variable proportions, according to the character of the substance from which it is made. As originally produced, gas is too impure to be burned without injury to those subjected to the influence of the matters given off by it during its combustion. These matters vary with the nature of the substance from which the gas is derived. Coal gas contains carbonic acid, carbonic oxide, sulphuretted hydrogen, ammonia, and cyanogen. These are removed in great part by causing the gas to pass through vessels containing lime, and sometimes by subjecting it to the action of other substances. Even, however, when every care is taken, a small quantity of carbonic oxide, vapor of bisulphuret of carbon, and ammonia still remain.

Good pure gas when burning does not evolve more deleterious matters than candles or oils, but it rarely happens that a portion of the gas does not escape unconsumed, and it occasionally happens that the gas is not as pure as it would be if proper care was always taken at the manufactory to insure the removal of the noxious substances. Moreover, when gas is at hand, a flame much larger than that made

by several candles is generally produced, and consequently the air so much the more contaminated.

Coal gas, as it is ordinarily found, when burned, besides producing carbonic acid and water, also evolves an acid vapor, which is sulphurous acid. This is derived from a small quantity of the vapor of bisulphide of carbon. If the gas be passed over hydrate of lime, heated to about 600°, the bisulphide of carbon is decomposed, sulphide of lime is formed, and sulphuretted hydrogen is set free.

The heat produced by gas is an objection to its use, especially in small rooms; I have found the flame from a single burner to raise the temperature of a room, containing sixteen hundred cubic feet of air, from 55° to 63° in one hour, and to maintain it at this point for several hours.

In regard to the extent of contamination produced in the air of houses by the artificial means of illumination employed, very definite results have been obtained. We know that combustion takes place at the expense of the oxygen of the air. Tallow, wax, spermaceti, oil, etc. contain, as an average, about 80 per cent. of carbon and 12 per cent. of hydrogen. In burning, these substances unite with the oxygen of the atmosphere, producing carbonic acid and water. In one hour I found a sperm candle burn away to the extent of 135 grains. In this amount are contained 108 grains of carbon, absorbing from the atmosphere 288 grains of oxygen to form 396 grains of carbonic acid, equivalent to 841 cubic inches. The room contained 1500 cubic feet of air, and had it been perfectly air-tight, and the candle had continued to burn for about forty-five hours, all the oxygen contained in its atmosphere would have been converted into carbonic acid. Experiment has shown, however, that air containing as much as ten parts of carbonic acid in one thousand is not fit to be inspired; 841 cubic inches of carbonic acid were formed in one hour, and consequently 84,100 cubic inches of air, or 58·4 cubic

feet, were so far deteriorated as to be unfit for the purposes of respiration. In twenty-five hours the whole air of the room would have been rendered injurious to health if respired, even if fresh oxygen had been supposed to take the place of that uniting with the carbon.

According to Liebig,* an adult man consumes 6000 grains of carbon in twenty-four hours, which is eliminated from the skin and lungs as carbonic acid gas. Scharling fixes the amount of carbonic acid formed at 13,438 grains daily, equivalent to the elimination of 3664·90 grains of carbon, the balance, 9773·10 grains, being oxygen taken from the atmosphere. Andral and Gavarret place the quantity of carbon at 4065 grains, and Carpenter at 3840 grains.

My own experiments† are to the effect that about 12,000 grains of carbonic acid are exhaled from the lungs in twenty-four hours. Of this 8728 consist of oxygen, which is derived from the air inspired. In addition, over 5000 grains of vapor of water are expired.

We have seen that a candle, in burning one hour, caused the formation of 396 grains of carbonic acid, equivalent to 9504 grains in the twenty-four hours, or but about 2456 grains less than the amount formed by the respiration of an adult man during the same period.

Now many candles burn away much faster, and give rise, in being consumed, to a considerably larger quantity of carbonic acid, so that it is within the bounds of fact to say that a candle, while burning, in the main causes as great a deterioration of the atmosphere as an adult person breathing in it during a similar length of time.

From the use of oils as illuminating agents, a larger amount of carbonic acid is formed if the better kind of

* Letters on Chemistry. London, 1854, p. 315.

† Physiological Memoirs, p. 47.

lamps are used, and from coal gas the quantity produced is still greater.

By accurate measurement I have found that a gas burner in the room in which I am in the habit of sitting, allows, when the gas is fully turned on, of the consumption of 4·25 cubic feet per hour. A cubic foot of coal gas gives origin, during its combustion, to about 1·25 cubic feet of carbonic acid, so that for each hour 5·3125 cubic feet, or 4322 grains, of carbonic acid are given off to the atmosphere of the room. For the twenty-four hours the quantity would amount to 128·50 cubic feet, or 103,728 grains.

It is thus seen that one such burner causes more carbonic acid to be formed in a given time than is evolved from the respiration of eight adult human beings, and consequently causes, so far as the carbonic acid is concerned, more deterioration of the atmosphere of a room than would be caused by the presence of eight individuals.

In addition, a large quantity of water is formed by the union of the hydrogen of the gas with the oxygen contained in the atmosphere of the chamber. Hydrogen is present in coal gas to the extent of about 23 per cent. A cubic foot therefore contains by weight 69·23 grains of hydrogen, and the quantity burned in one hour (4·25 cubic feet) 294·22 grains. This would unite with 2352 grains of oxygen (about 4 cubic feet) to form 2646 grains of water. In a day 96 cubic feet of oxygen would be taken from the atmosphere and 63,504 grains of water produced. We see therefore how greatly the atmosphere of an apartment is affected by the combustion from one burner, and we can of course perceive how vast is the deterioration in a room where there are several burners from which gas is consumed. In a ward where there are eight, as there are in most of the wards of the large hospitals, the deterioration from carbonic acid would be equal to that produced by adding sixty-four patients to the complement of the ward.

Now we have seen that air containing 10 parts in 1000 of carbonic acid is not fitted for the purposes of respiration, not so much, as has also been shown, from any positively noxious qualities pertaining to carbonic acid as to the fact that the presence of this gas is a hinderance to the perfect oxygenation of the blood. We have also seen that a single burner in a single hour causes the formation of 5·3125 cubic feet of carbonic acid gas. We may safely assume that the gas in a hospital ward is burned for three hours each day; there would therefore be formed in the course of a single evening from each burner 15·9375 cubic feet of carbonic acid, a quantity sufficient to render 1593·75 cubic feet of air unfit for respiration. Eight burners would vitiate 12,750 cubic feet of air, or the space that would ordinarily be occupied by ten patients.

The Mower Hospital at Chestnut Hill, already described, is lighted by 1050 gas burners. The consumption of gas in a single month reaches the enormous quantity of 178,260 cubic feet, from which 222,825 cubic feet of carbonic acid are formed, sufficient to vitiate, so as to render it unfit for respiration, 22,282,500 cubic feet of air. In a single night 7,427 cubic feet of carbonic acid gas are produced, sufficient to vitiate 742,700 cubic feet of air. In the absence of positive data, it may safely be assumed that half the number of burners in the whole hospital are in the wards, and consequently in a single evening 371,350 cubic feet of air are so far contaminated as to be seriously detrimental to the health of those obliged to respire it. The total amount of space available for patients does not exceed 3,000,000 cubic feet, so that one-ninth of the whole capacity of the hospital, or the space occupied by about 330 patients, is rendered unfit for them by reason of the vitiation of the air they are obliged to respire.

It is of course to be understood that these consequences are based upon the conditions that would result if the con-

taminated atmosphere was suffered to remain in the wards unchanged. They are merely adduced for the purpose of showing how very important it is that a sufficiently enlarged idea of the vitiation caused by artificial illumination should be formed, in order that adequate means may be taken for the removal of the noxious products.

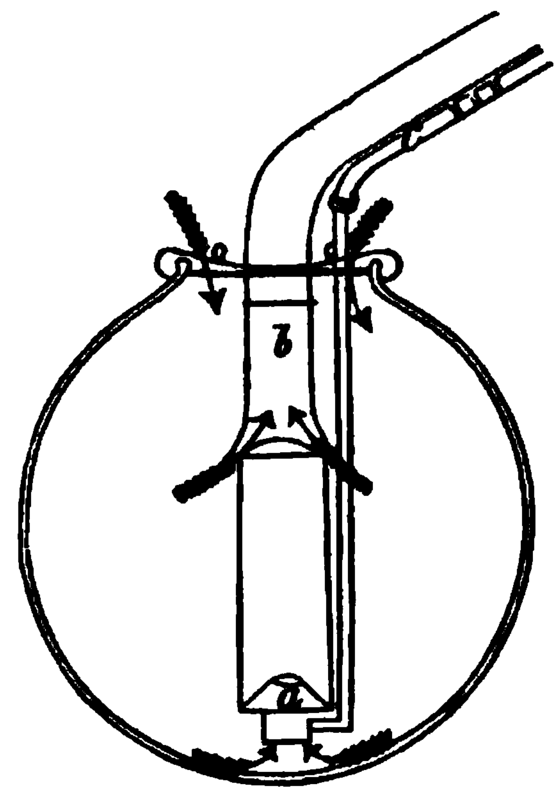
It is perfectly possible so to ventilate the gas burners as not only to cause the products of combustion to be removed, but also to aid in the abstraction of other noxious matters which are present in the air of inhabited apartments. By the ordinary ridge ventilation this is thoroughly accomplished so long as the ventilators are left open, as during the warm seasons of the year; but in winter, when they are closed, and the system described on page 356, and represented in Fig. 45, is employed, the gas burners are not sufficiently ventilated, and hence other means should be brought into action.

It should undoubtedly be the case that all gas burners in private houses, and other buildings where people reside or congregate, should be ventilated. When gas was first employed it was much more impure than it is now, and serious objections existed on that account to its introduction into houses. It was found that a considerable proportion of sulphur was evolved, which, condensing upon furniture, plate, books, etc., caused a good deal of damage. Serious injury was sustained by the library of the Atheneum Club from this cause.* It therefore became a matter of importance to remove the noxious vapors, if not for the preservation of the health of the inmates, at least for the prevention of injury to their household effects. Sir Michael Faraday, by an ingenious arrangement, caused a descending current to carry off the products of the combustion

* Ronalds and Richardson's Chemical Technology, vol. i. part ii. p. 674.

through a tube leading to the chimney flue. The arrangement was improved by Mr. Rutter, an idea of whose ventilating gas burner will be obtained from the accompanying cut, (Fig. 66.) The burner is shown at *a*, with a chimney

Fig. 66.

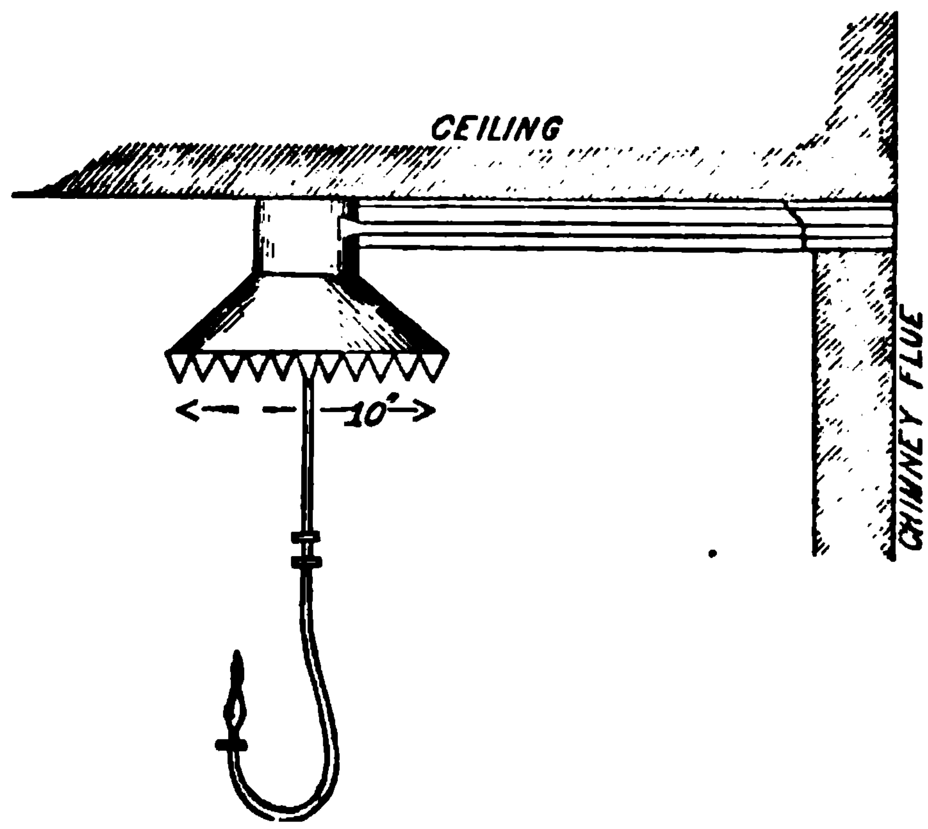


discharging into the metal tube *b*, which is attached to the gas pipe *c*. A glass globe, open only at the top, is suspended by the rim to an attachment to the metal tube *b*; the air enters in the direction of the arrows, feeds the flame at *a*, and escapes through the tube *b*, carrying with it to a flue the products arising from the combustion of the gas. The advantages of such an arrangement are at once seen, for not only are the matters due to the burning of the gas removed, but a strong current is excited, by which other impurities are drawn off.

A simpler but less elegant, though equally effectual plan, is shown in Fig. 67. An ordinary gas burner has immediately above it, at the distance of about three feet, a tin or iron funnel, into which a tube opens, communicating at the other end with the chimney of the room. An upward current is thus established, which not only ventilates the gas burner, but also aids materially in the removal from the room of impurities derived from other sources. Such

an arrangement as this should be adapted to every gas burner in hospital wards. In the temporary military hospitals, instead of passing to the chimney the flue might proceed directly to the roof, and escape to the exterior at the ridge. In the winter it would prove no immaterial means of adding to the ventilation of the ward.

Fig. 67.



From a consideration of the points brought forward relative to artificial illumination, I trust it will be made sufficiently apparent that it is almost as necessary to get rid of the products of the combustion of the illuminating material as of the exhalations from the bodies of the patients who may be in the wards of a hospital. If we regard alone the carbonic acid and vapor of water which are formed, there is a much greater reason for ventilation, as the products are so much larger; but as the human body throws off a quantity of organic matter which, as has already been shown, is far more injurious in its action than carbonic acid, the necessity for general ventilation is still more imperative. The principles by which it is to be accomplished will be indicated in their more striking features in a following chapter.

CHAPTER XVII.

HEATING OF HOSPITALS.

In artificially heating buildings the same difficulties are to be met as in producing artificial illumination, unless the air is warmed in the manner to be described, by radiation from or contact with pipes containing steam or hot water.

The substances which are used to produce heat must contain a large amount of carbon and hydrogen in order to be economical, these being the matters which, by their combustion, cause the greatest evolution of caloric. These substances are known as fuel, and are of vegetable or animal origin. Those of the first-named class are wood, peat or turf, lignite, bituminous and anthracite coal, wood-charcoal, peat-charcoal, coke—or the charcoal from coal—alcohol, ether, and vegetable oils. All of these, except the three last, are essentially woody fiber, and, with the exception of the first named, have been changed by natural or artificial causes to the condition in which they are found. Thus peat is produced from the long-continued action of water on vegetable matters, whereby they are converted into a soft soap-like mass of a black color; lignite is fossil wood of a comparatively early formation; bituminous coal is still older, and contains more carbon; and anthracite is the oldest of all, and is harder than the former, from which it chiefly differs in the fact that the process of carbonization is further advanced than in the others. It ignites with difficulty, and only in a strong current of air, burning without the evolution of smoke. The following table exhibits the composition of several kinds of coal:

	Newcastle.	Staffordshire.	Wigan cannel.	Anthracite.
Carbon	81·41	78·57	80·07	90·89
Hydrogen	5·83	5·28	5·53	3·28
Oxygen	7·89	12·88	8·09	2·97
Nitrogen	2·05	1·84	2·12	0·83
Sulphur	0·75	0·39	1·50	0·91
Ash	2·07	1·03	2·70	1·61
Specific gravity	1·276	1·278	1·276	1·392
Approximate formulæ	$C_{27}H_{11}O_2$	$C_{26}H_{10}O_3$	$C_{26}H_{10}O_2$	$C_{40}H_3O$.

From this table an idea can be formed of the character of the matters given off by the combustion of coal, and the necessity for removing the gaseous products which result from its oxidation.

Coke is produced from coal being heated, with deprivation of air, to such an extent as to drive off the volatile matters, leaving behind a porous substance, consisting of carbon and earthy substances, which is the coke. The several kinds of charcoal are formed by burning wood or peat in confined spaces. As with coal, the volatile products are separated, and the charcoal remains. Alcohol and vegetable oils have but a limited application as producers of heat, and ether is still less used.

The animal oils and fats are occasionally used for heating purposes, but their employment in this direction is not extensive.

Illuminating gases are also used as fuel, especially in connection with the arts and sciences.

The substances known as artificial fuel scarcely deserve the name, as they consist of saw-dust, coal-dust, etc. cemented with tar or bitumen.

All kinds of fuel do not, in burning, evolve like quantities of heat. The differences to be observed in this respect are very striking, and are shown in the following table, which indicates the quantity of water which one pound of

each of the substances specified will raise from 0° to 100° centigrade, or from 32° to 212° Fahrenheit.

Hydrogen	236
Pure carbon	78
Wood charcoal	75
Dry wood	36
Wood containing 20 per cent. of water	27
Good coal	60
Peat	25 to 30
Alcohol	67
Ether	80
Vegetable oil, rape oil, wax, etc	95

Hydrogen, therefore, is pre-eminent as a heat-producing substance, and a fuel is valuable in proportion to the amount of this element entering into its composition.

So far as the hygienic value is concerned, the case is different as regards the compound substances. Hydrogen, in burning, gives rise to no other substance than water, and consequently it would be, as it is the best heat producer, also the most valuable in a sanitary point of view; but pure hydrogen is, on many practical accounts, inadmissible for the ordinary purpose of fuel, and compound bodies in which it exists in greatest quantity have associated with it other substances which, in the process of combustion, give origin to vapors and gases which are highly deleterious in their character. Thus the various kinds of coal contain sulphur, from which sulphurous acid and sulphuretted hydrogen are formed—both in the highest degree prejudicial to health. Nitrogen is present, which, uniting with hydrogen, gives origin to ammonia, which is extremely irritating to the respiratory passages. A portion of the carbon unites with a portion of the nitrogen and hydrogen, and hydrocyanic acid is produced, not in large quantity, but yet in sufficient amount, if not removed, to cause very considerable disturbance in the healthy working of the organism. The rest of the carbon, which is consumed, unites with the

oxygen of the air to form carbonic acid and carbonic oxide, the latter a substance extremely poisonous in its action on the system when inhaled into the lungs; but from bituminous coal a considerable amount escapes unconsumed in the form of smoke, which consists of small particles of pure carbon. In many places where large quantities of bituminous coal are burned, the smoke is a source of much discomfort. Coke, during combustion, yields sulphurous acid, carbonic acid, and carbonic oxide; and charcoal also gives rise to the two last-named substances while burning. The many suicides and accidental deaths which have been caused by burning charcoal have been due to the inhalation of the carbonic oxide evolved during the process. Wood, when burned, gives off a large quantity of carbon in the form of smoke, the vapor of water, empyreumatic oils, carbonic acid, and carbonic oxide. The irritating qualities of wood smoke are due to these empyreumatic substances, among which creosote is the chief.

Now in order to obtain heat from fuel, without at the same time subjecting ourselves to the action of the noxious substances mentioned, various contrivances have been devised which, with more or less completeness, allow of the removal of the deleterious matters, or which are placed at a distance from the apartments to be warmed, and heat them through the medium of water, steam, or by currents of hot air. These are open fire-places, stoves, furnaces supplying hot air, steam apparatus, and hot water apparatus.

The *open fire-place* is, on several accounts, to be preferred to any other means of heating an apartment. It insures, when well constructed, the removal of those products of combustion which tend to vitiate the atmosphere, and at the same time causes a strong current of air to pass from the room through the chimney, by which alone tolerably effective ventilation is produced.

But it has certain objectionable features which preclude

its employment when a steady and uniform heat is required, and when it is especially desirable to avoid irregular currents of air. It is therefore not adapted for use in large rooms, such as hospital wards, where many sick persons are present. If wood is the fuel used, the frequent necessity of replenishing the fire, the lowering of temperature which ensues if there is the least neglect in attending to this point, and the great loss of heat through the chimney afford almost insuperable reasons against the open fire-place during the colder months of the year. If coal is burned, although there is more heat, yet it is impossible to avoid the exhalation of a portion of the deleterious gases and vapors throughout the chamber; and the dust, in the form of ashes, which is profusely scattered, adds seriously to the inconvenience and unhealthiness. In addition, the warmth from a fire-place is not generally diffused throughout the room. The heat is almost entirely communicated by direct radiation, and consequently while that part of the body turned toward the fire is heated perhaps to excess, the portions not exposed to the rays of heat are not sufficiently warmed.

On the other hand again, the cheerfulness imparted to the mind by the sight of an open fire should not be overlooked, and the influence of the light emitted is also an important element in the consideration of the subject; so that while, as has been said, the objections applicable to the use of open fire-places in large rooms, especially those inhabited by sick persons, are almost insurmountable, the advantages from them will always cause their employment in smaller rooms, inhabited but by one or two persons, and in cases where economy is no object. When used, wood is to be preferred, and next, good bituminous coal. The gases evolved from anthracite, coke, and charcoal are much more deleterious, and, as has been said, a portion will unavoidably escape into the air of the room. There are many

persons who cannot endure an anthracite or coke fire in an open fire-place without headache or bronchial irritation being the inevitable consequence.

Stoves are of so many different patterns that to describe them all, or even a tithe of them, would require more space than could profitably be devoted to their consideration. There are certain general features which are attached to all stoves without reference to the material of which they may be constructed, or the peculiar pattern after which they are formed.

Stoves not only heat the atmosphere by radiation but also by conduction, and hence any organic matters which may be suspended in the air are volatilized on coming in contact with the heated metal. In an open fire-place a great portion of the heat, amounting generally to as much as 90 per cent., is drawn up the chimney, but that given off from a stove is retained in the room to a much greater extent.

A serious objection to stoves is, that as the air surrounding them becomes heated and specifically lighter, it ascends to the ceiling, and therefore the lower strata of air contained in a room heated by a stove are never so hot as the upper.

Another objection arises from the dryness of the atmosphere which is produced by the heat of a stove. It is customary to have a vessel on top of the stove containing water, by the evaporation of which this evil is partially obviated, but it is not altogether got rid of, and the arrangement requires attention which is seldom given to it.

Stoves in which coal is burned always allow the escape into the apartment of a portion of the gases and vapors given off during combustion. If wood is the fuel, this source of vitiation is not so great, as the gases which arise from the burning of wood are lighter than those from coal,

and consequently there is a greater tendency for them to escape through the pipe. Moreover, coal always contains mineral substances, such as sulphur, which, being volatilized, are diffused more or less completely, in the form of vapor, throughout the room. On this account coal stoves are exceedingly unfit for rooms in which invalids are confined, but, as they are economical and require little attention, they are used in the temporary military hospitals of the country. The civil hospitals, without, so far as I know, an exception, are heated by more improved methods.

Furnaces placed at a distance from the apartments to be heated, generally under them, are modifications of the ordinary stove, differing only in the fact that air is brought to the stove, heated by conduction, and then allowed to ascend to the rooms through pipes or flues. If proper precautions are taken to insure a full supply of fresh air from the outside, to prevent the mixture of the gases from the fuel with the hot air, and to provide sufficient moisture, this method of warming is not very objectionable. It, however, almost invariably happens that proper measures are not taken to insure these ends, and consequently the air of apartments heated by subterranean furnaces is almost always oppressive. It is only necessary to allow a piece of polished silver to stand for a few days in a room warmed in this manner to be convinced of the presence of the vapor of sulphur in the atmosphere, as the silver very rapidly becomes tarnished by the formation of the sulphuret. I have also caused the warmed air to pass through Liebig's potash-bulbs, and have always found an excessive amount of carbonic acid to be present. And yet I have seen educated persons, or those who from their position in life ought to have known better, crowd themselves, to the number of five or six, into a room scarcely fifteen feet square, in which there was no window, in which two gas burners were lighted, and with the doors shut,

crouch over a flue from a red-hot furnace, through which air hot enough to parch the skin was being discharged with horrible rapidity. Should it be a subject for surprise that such persons were annoyed with coldness of the extremities, and were haggard and ghastly looking in the morning, and that they were afflicted with almost constant headaches, dyspepsia, and other affections evincing disorder of the organism? As used in this country, hot-air furnaces, I have no hesitation in saying, are productive of more disease and discomfort than are caused by all the other means of producing artificial heat combined.

Buildings are sometimes heated by *steam*, which, by some, is considered to possess advantages over hot water used in a similar manner. A boiler is fitted up in some convenient place, and the steam is either conveyed in pipes directly to the rooms to be heated, or hot air is caused to come in contact with coils of pipes containing steam, and then admitted to the apartments.

The chief disadvantage of steam as a heating agent consists in the fact that it is difficult to regulate the temperature. The pipes must be kept at 212° Fahrenheit, or condensation of the vapor at once takes place and water is formed. In passing from a state of vapor to that of a liquid, steam parts with its latent heat, which becomes sensible, and thus the temperature of the pipes is raised. The latent heat of steam being 1000°, a great source of heat is thus at command; but if the pipes are allowed to cool again below 212°, a fresh portion of steam is condensed, and so on till the whole of it has been converted into water and has parted with all its latent heat. It now occupies but $\frac{1}{1728}$ part of the space as water which it did as steam, and consequently has a heating power equivalent to that of an equal bulk of water. Bulk for bulk, the heating power of steam compared to that of water is as 1 to 288—that is, a cubic foot of water will give out 288 times as much heat

as a cubic foot of steam in passing from 212° to 60°. Bringing into consideration other factors, such as the specific heat of the iron of which the pipes are made, the heat from the water contained in the boiler, and of the brickwork around the boiler, it is found that a building warmed with hot water will maintain its temperature, after the fire is extinguished, about six or eight times as long as it would do if it were heated with steam.*

The air warmed by steam is not baked, as is that which comes in contact with the heated surface of a stove, and hence is not deprived, to an equal extent, of its moisture. It is therefore less irritating to the lungs, and being absolutely uncontaminated by the vapors and gases given off by the burning fuel, is altogether preferable to any direct means of heating.

There are many forms of steam heating apparatus in use, some of which are preferable to others. The subject in these relations will be best studied from the works specially devoted to the consideration of the principles of artificial heating.

Hot water affords another excellent means for obtaining artificial warmth, and the principles upon which the process is conducted do not differ essentially from those which govern that last described. Pipes are arranged in connection with a boiler containing water. Heat being applied, those particles of the water nearest to the source of the heat first become warmed, and at the same time specifically lighter. They consequently rise to the top of the boiler and enter the pipe, which conveys them throughout the building to be warmed. If this water were allowed to escape, there would be a constant necessity for replenishing the boiler; but after it has lost a portion of its heat it is

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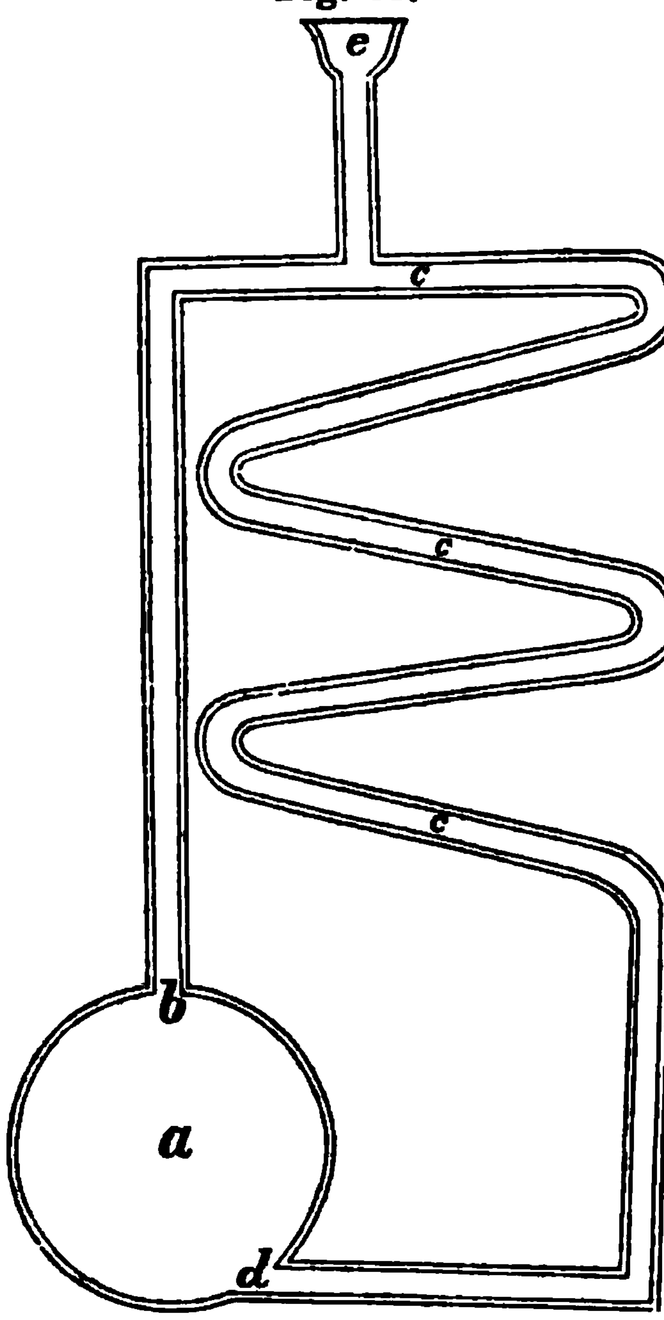
* A Practical Treatise on Warming Buildings by Hot Water, etc., by Charles Hood, F.R.S., etc. London, p. 61.

returned to the boiler, and the process is repeated. An idea of the arrangement will be obtained from the accompanying cut, (Fig. 68,) in which *a* indicates the boiler, *b* the mouth of the tube through which the hot water is distributed, *c c* the tube as it ramifies through the building, inclining, after it has passed a certain point, toward the boiler, and emptying into it at *d*; at *e* a tube is shown by which the air is allowed to escape from the water.

Fig. 68.



The pipes may be arranged in coils, contained in boxes under the floor, communicating with the external atmosphere. A register in the wall or floor allows the hot air to enter the chamber.

Hot water has almost entirely superseded steam as a heating agent. Its effects are more uniform, and it is also more economical. The first employment of this means is usually ascribed to M. Bonnemain, who made use of it in 1777, in an apparatus for hatching chickens,* but Tomlinson† assigns the credit to Sir Martin Triewald, a Swede, who, in the year 1716, warmed a greenhouse by hot water. The water was boiled outside the building, and then conducted by a pipe into a chamber under the plants. Water was heated for the baths of the

* A Practical Treatise on Warming, etc., by Charles Hood, F.R.S., p. 4. Reid on Ventilation, etc., p. 242.

† A Rudimentary Treatise on Warming and Ventilation. London, 1850, p. 131.

ancient Romans by passing it in coils of pipes through fire, but this was not for the purpose of communicating warmth to the atmosphere.

It is highly probable that warm water was in use for heating the air of houses long before any experiments on the subject by Triewald or Bonnemain, and I have been able to find a reference to it which fixes its use at a much earlier date. In a work published in 1745,* to which reference has already been made, it is stated that a certain Danish sea captain, by name Jacob Hall, met at Iceland a monk who, in the year 1546, lived in Greenland, and who, among many other things, told him "that in the convent of St. Thomas, (in Greenland,) where he had passed much time, there was a well of burning hot water, which, through pipes, was conveyed into all the rooms and cells of the convent for to warm them." It is also affirmed that "Nicholas Zenetur, a Venetian by birth, who served the King of Denmark in the quality of a sea captain, is said by chance to have been driven upon the coast of Greenland in the year 1380, and to have seen that same Dominican convent. His relation is abridged by Kircherus in the following words: 'Here is also a Dominican convent to be seen, dedicated to St. Thomas, in whose neighborhood there is a volcano of a mountain that spews fire, and at the foot thereof a well of burning hot water. This hot water is not only conveyed by pipes into the convent and through all the cells of the friars to keep them warm, as with us the rooms are heated by stoves of wood fire or other fuel, but here they also boil and bake their meat and bread with the same.'"

It is only within the last twenty-five or thirty years

* A Description of Greenland, showing the Natural History, Situation, etc., by Mr. Hans Egede, Missionary in that country for twenty years. Translated from the Danish, p. 20.

that hot water has been much used for heating buildings, and it is not yet employed to as great an extent as its merits warrant. Hygienically there is nothing, beyond the fact that hot water parts with its heat less rapidly than steam, that makes it preferable to this last-named agent, but this one circumstance renders it more generally applicable for heating hospitals. One or the other should always be used; the objections to open fire-places, stoves, and hot-air furnaces have already been mentioned: they are of such a character as renders them unfit to be used in rooms intended for the reception of many sick persons. The hot water apparatus also admits of any degree of heat between 212° and the temperature of the atmosphere being obtained, and on this account its advantages are very decided.

Many forms of apparatus are in use for heating by means of hot water. All require to be carefully adjusted; but as the subject is now thoroughly understood, little difficulty is experienced on this account. Most of the hospitals of Great Britain, France, and the United States are warmed with either hot water or steam. Any other means should, as we have said, be condemned, and can only be tolerated when it is impossible to obtain either of those cited.

One of the principal duties which medical officers in charge of hospitals have to perform is the regulation of the temperature of their wards. The stoves which are in use in the temporary general hospitals scarcely admit in very cold weather of obtaining a satisfactory and uniform heat in a ward. In the vicinity of the stove the temperature will be greater than is neeessary, while at the distance of a few feet it is much less than is proper. A uniform temperature is highly desirable, and it should, in winter, be from 60° to 62° of Fahrenheit. At night it may be allowed to fall as low as 50°, but should never reach that of the external atmosphere, or even to 35°. No other

means than hot water or steam will permit of uniformity of temperature or of regulation at will.

Other means of heating, such as by gas, artificial fuel, etc., we pass over as not at all applicable to hospitals. It is more than possible, however, that stoves for burning gas will eventually be constructed which will fulfil every indication, but at present they are far from being fit for the purpose, and are in the highest degree injurious to the health of those using them. A gas grate which is used in England, and which consists of a coil of gas pipe perforated by numerous small holes, is the best apparatus I have seen for burning gas as fuel. Pieces of asbestos are thrown over the pipe, and these, becoming incandescent, give the fire very much the appearance of that produced by live coals.

CHAPTER XVIII.

VENTILATION OF HOSPITALS.

We have already made many allusions to ventilation, and have described the ridge ventilation in use in the temporary military hospitals, and the substitute for it, to be employed during the winter months. The necessity for efficient ventilation has also been pointed out; and the deleterious consequences of inspiring air which has been contaminated by the respiration of many persons, by the emanations from sewers and cess-pools, and by the means used to produce artificial illumination and warmth have likewise been considered to some extent. It is expedient, however, that these points should be still further dwelt upon, in order that certain subjects may receive more attention than could be given to them under other heads,

and to bring forward certain facts which, for the same reason, could not otherwise be adduced.

Confined air, under all circumstances, is injurious if inhaled into the lungs. Though it may not have been vitiated by respiration, by combustion, or by emanations from known sources of contamination, the mere fact of its having been stagnant is sufficient proof of its unwholesomeness. It is very much with air as with water; it requires to be kept in motion to be retained in a condition fit to enter the system.

On entering a room which has been kept closed for some time a peculiar and characteristic odor is perceived. This fact of itself is evidence against the insalubrity of the air for it may be laid down as a law, admitting of very few exceptions, that air which is capable of making an impression on the sense of smell is not suitable for the purposes of respiration.

Now what can communicate an odor to air which has been subjected to none of the ordinary and recognized causes of vitiation, but which has simply been retained in a closed chamber? The matter is a very simple one. The air of such a chamber always contains organic substances, animal and vegetable. The emanations from the last occupant, the fibers from carpets, blankets, curtains, linen, etc., the vapors which are given off from the varnish and paint of the furniture and other wood-work, and from the wood itself, and the various substances, such as spores, starch, etc., which find entrance into any place not absolutely air tight, are all there and undergoing decomposition. Stagnant air therefore presents another point of analogy to stagnant water; it contains animal and vegetable bodies which are undergoing decomposition. The subject admits of positive experimental illustration.

I placed an exhausting apparatus, connected with a set of Liebig's bulbs, containing a standard solution of perman-

ganate of potassa, in a room which had been immediately before thoroughly aired. The apparatus was set in action, and it was found that it required 1085 cubic inches of air to pass through the solution in order to decolorize it. In my office, which is a large room, well ventilated, and in which only one person is generally present, 979 cubic inches of air decolorized the solution. The air of the first-named room was therefore freer from organic matter than the last.

The windows and doors of the room were now closed, and it was not entered or opened for ten days. At the end of that time the apparatus above described was introduced and put in operation. It was now found that 725 cubic inches of the air were sufficient to effect a complete decolorization of the solution of permanganate of potassa, and consequently more organic matter was present in the atmosphere of the room than ten days previously after complete ventilation.

At the same time experiments were conducted relative to the proportion of carbonic acid present, a similar arrangement — the potash-bulbs containing a solution of caustic potassa—being used, and chloride of calcium tubes being added to the apparatus to absorb the moisture of the air before passing through the potash solution. On the first occasion it was found that 10,000 cubic inches of air contained 3·5 cubic inches of carbonic acid. On the second, after the room had been closed for ten days, the carbonic acid had become increased to 3·9 cubic inches in 10,000 of air.

We have thus a ready explanation of the cause of the odor and of the unhealthy character of air which has been so conditioned as to have become stagnated. We see therefore that one of the most essential conditions of the fitness of air for respiration is that it shall be kept in motion, and hence if there were no more positive and

potential causes of vitiation than those mentioned as acting upon the air of a close room, the necessity for ventilation would be still very great.

When, however, in addition to stagnation or insufficient motion are added the many causes of contamination which result from animal life and the various artificial processes connected with it, the need of change in the atmosphere of an apartment becomes much more imperative, and cannot be resisted without danger not only to health but to life.

We have already seen how injurious to life are the emanations from the animal body, and how important it is for the comfort and existence of the sick that an ample allowance of air should be supplied to them. We have now again to draw special attention to the subject and to point out the absolute necessity of frequently renewing the air which is to be taken into the system to aid in maintaining the proper working of the functions of the organism.

We have seen that the essential constituent of the atmosphere, so far as the process of respiration is concerned, is oxygen, and that anything which interferes with the supply of the proper amount of this element is a source of discomfort if not of disease. We have also seen that the process of respiration causes an absorption of oxygen and the substitution of carbonic acid and water for it, and that in addition there are organic emanations from the skin and lungs, the action of which, when again caused to enter the system through the lungs, is positively fatal if the process is carried on even for a comparatively short period.

I have already expressed the opinion that a proportion of carbonic acid, not exceeding ten parts in one thousand of air, is injurious to the health of those breathing such an atmosphere. There can be no doubt that such is the case, but there is reason to believe that a proportion much less than this will produce effects detrimental to the well-being of the organism. An individual placed suddenly in an at-

mosphere of pure carbonic acid gas would die with the same symptoms and from essentially the same cause as if a cord had been tightly tied around his trachea. The entrance of atmospheric air to his lungs would be in both cases effectually prevented, not, as we have seen, from the absorption, in the first case cited, of any portion of the carbonic acid, but from the fact which would equally exist in the second, that no oxygen would reach the lungs. What is true of a whole is true of a part, and we may therefore assume with certainty that the smallest possible proportion of carbonic acid in the atmosphere renders in some measure that atmosphere unfit for respiration. The effect may be so small as to be inappreciable at once, but it is there, and if the cause is continued, the result will inevitably show itself.

It is rarely the case that the wards of a hospital can, by any system of ventilation, be so freed from carbonic acid, aqueous vapor, and organic emanations that the contained atmosphere will be identical in composition with that of the outside of the building. It is altogether too much to expect this. If such a condition could be brought about, hospitals would be removed from the operation of that cause which of all others is pre-eminent in rendering them insalubrious. But though we cannot obtain perfection of ventilation, we can adopt means which are so efficacious, in removing the excreta from the skin and lungs from inclosures, that the injury they can produce is reduced to an amount extremely small.

No duty is more imperative upon those having charge of hospitals than that of doing all in their power to insure, as nearly as possible, complete ventilation of the wards under their charge. I have inspected hospitals where no attention whatever was paid to this point, where the fact that dozens of patients affected with typhoid fever, dysentery, and other zymotic diseases were breathing over and over

again the same air, was either unnoticed by the medical officers or uncared for. They could complain that some refined medical preparation for which they had asked was not forthcoming, but their own criminal neglect of the first of nature's laws, their ignorant or wilful disregard of the lives of those so unfortunate as to be committed to their care, was of far less importance in their estimation than an alleged deficiency of certain drugs. No better test of the professional fitness of a physician or surgeon to take the charge of a hospital can be found than the estimate which he puts upon the importance of providing an abundance of fresh air for his patients.

I have recently examined the wards of several military hospitals. With one or two exceptions all were in good condition, and especially so as regarded ventilation. The ridges were open, and an abundance of fresh air entered through the openings in the sides of the wards. The amount of cubic space varied from 900 to 1100 cubic feet, which, in temporary pavilion hospitals, is an ample allowance. Nevertheless, in those which were in the best order the amount of carbonic acid present was 0·68 in 1000 volumes of the contained atmosphere, while outside it was but 0·37 per 1000. In the hospital in which the least attention was paid to ventilation the proportion was 2·11 parts to 1000 of air. Even this last result is better than some of those obtained by Leblanc,* who, in one of the wards of the Salpetrière, found 8 parts in 1000 of air by weight, or 5·33 parts by volume. Ramon de Luna,† in one of the wards of the Princess's Hospital of Madrid, detected 3·0 parts of carbonic acid in 1000 of air by volume, and in the General Hospital as much as 4·3 parts.

With regard to the amount of organic matter present,

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* Annales de Chimie et de Physique, 1842, tome v. p. 260.

† Annales d'Hygiène, 1861, tome xv. p. 361.

my observations led only to comparative results, but they accorded very closely with those relating to the proportion of carbonic acid present. A solution of permanganate of potassa—which was decolorized in the open air only after 1353 cubic inches of air had passed through the arrangement—was, in the hospital which contained the least amount of carbonic acid gas in the atmosphere, decolorized by 801 cubic inches, and in that which contained the most by 617 cubic inches.

Hospitals have always been recognized as in themselves great causes of disease unless unremitting care is taken to provide means for continually changing the atmosphere of their wards. Even with every effort dictated by the most thorough acquaintance with the science of hygiene, and the most conscientious endeavors to discharge faithfully the duties of his office, the medical officer of a hospital will sometimes find diseases originate under his eyes which can only owe their source to infection. When there is perfect ventilation there is no infection. Contagion can only act in confined air. Erysipelas, pyemia, hospital gangrene, typhus and typhoid fevers are diseases which are almost unknown among individuals not exposed to the dangers resulting from overcrowding and want of fresh air; and the best means of lessening their malignancy and of preventing their spreading is separation of those among whom they exist or who are subject to the effluvia by which they are caused. M. Larrey,* in calling attention to this subject, says:—

"The danger of infection depends upon the vitiation of the atmosphere, especially during the night. The natural excretions of the sick—the breath, the fetid perspiration, the expectorated matter, the intestinal and urinary evacuations, the suppurations from wounds and ulcers, and some-

* Notice sur les Hôpitaux Militaires, etc. Paris, 1862, p. 28.

times the putridity of mortification or of hospital gangrene —are so many sources or foci of contamination, without counting the odors of medicines, of tisans and poultices, the evaporations from liquids, the emanations from the soil, from the oil or gas used for illumination, from the bed linen, and from the too closely situated or badly constructed latrines."

Lévy* is equally emphatic:—

"I repeat what I have said before, that I am far from denying the importance of diet, of curative methods, of careful attention, of an efficient administration, etc., but all these elements of hospital service are secondary to the necessity for having pure air. Bring them to the highest degree of ideal perfection, and if the air is vitiated, or if it is insufficient in quantity, neither improvement is manifested nor the mortality lessened."

The instance of the prisoners confined in the Black Hole at Calcutta has already been adduced as affording an example of the effects of a vitiated atmosphere; others were brought forward as being caused by overcrowding in prisons; and it would be very easy to cite many more, all showing the deplorable results of deficient space and ventilation. The instances which occurred at St. Cloud are too striking to be overlooked, and should be a warning against the crowding of soldiers. The king was in the habit of spending a portion of the year at the palace, and it was remarked that invariably about a week after his arrival the garrison was attacked with a malignant epidemic of typhoid fever. The inhabitants of the town always escaped; it was confined altogether to the privates, the non-commissioned officers being unaffected. Attention being at last forcibly directed to the matter, it was not

* Sur la Salubrité des Hôpitaux en Temps de Paix et en Temps de Guerre. Paris, 1862, p. 12.

difficult to ascertain the cause. The ordinary garrison consisted of about 500 men, who occupied barracks sufficiently large for their accommodation; but when the king came, the force was increased to over 1200 men, the additional number being crowded into the rooms previously occupied by but 500. The consequences were invariable, for no one, not even kings, can violate the laws of hygiene with impunity. The non-commissioned officers had ample space, and hence their immunity.

The Crimean war afforded many examples of the consequences following a disregard of the first principles of hygiene. In both the English and French armies the evil of bad ventilation, or rather no ventilation at all, was perhaps the greatest cause of the frightful suffering and mortality which prevailed in the allied forces. It can scarcely fail to impress upon army medical officers the importance of the most thorough attention being given to this subject if a few instances of the conditions under which the sick of these armies suffered are brought forward.

The Commission* dispatched to the seat of war by the British Government, in speaking of the Barrack Hospital at Scutari, state that the first thing that attracted their attention on entering the hospital was the defective state of the ventilation.

"Excepting a few small openings here and there, there were no means of renewing the atmosphere within the hospital. The large cubic space above the top of the ward windows always retained a considerable amount of hot and foul air, for which there was no escape. There was not even an open fire-place connected with the building, and the wards were heated by stoves, the pipes of which passed through a small hole at the top of one of the windows.

* Report to the Right Hon. Lord Panmure, G.C.B., etc., Minister at War, of the Proceedings of the Sanitary Commission dispatched to the Seat of War in the East, 1855–56. London, p. 12.

"There was no communication between the wards and corridors in the majority of instances, except by the doors, and hence that free circulation and perflation of the atmosphere, so necessary in military hospitals, was impossible.

"The wards and corridors being both occupied by sick, they could in fact be considered only as two hospitals built back to back, with the foul air in each intermingling by the doors.

"The effluvia from the privies had free access to the corridors, and added materially to the impurity of the air."

Similar remarks are made of nearly all the other hospitals.

Miss Nightingale,* in referring to the hospital at Scutari, says that—

"With regard to the ventilation, scarcely anything had been done, up to the arrival of the Sanitary Commission, March 6th, 1855, to improve its state in the Barrack Hospital, not even as much as breaking a pane of glass in the privies.

"What they did, show its defects; and what the atmosphere was at night in that hospital, especially in corridor and wards, it is impossible to describe or to remember, without wondering that every patient in them was not swept off by fever or cholera."

M. Baudens† ascribes the terrible epidemic of typhus fever, which prevailed among the troops in the Crimea, to the impossibility of isolating those attacked and of obviating overcrowding.

Jacquot‡ says there is no typhus in summer, for then the soldier lives in the open air and in open barracks and tents.

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* Notes on Matters affecting the Health, Efficiency, and Hospital Administration of the British Army, etc. Presented by Request to the Secretary of State for War. London, 1858, p. 87.

† Le Guerre de Crimée, etc., p. 244.

‡ Du Typhus de l'Armée d'Orient. Paris, 1858, p. 65.

According to this author, in 1856 a part of the French army lived in huts insufficiently ventilated. After the fatigues of the trenches, wet often with rain or snow, the soldiers would return to their tents, close every opening, light what fire they could, and then swelter in the vitiated atmosphere produced by the smoke of tobacco, the evaporation from their wet garments, and their own fetid exhalations. Is it any wonder that typhus broke out among them?

Cazalas* ascribes this typhus epidemic entirely to the aggregation of men, and to consequent concentration of the effluvia from their bodies, with deficient ventilation.

In our own service, though it must be confessed that sufficient attention to ventilation has not always been given by those having the charge of hospitals, nothing equaling, in this respect, the deplorable condition of the allied armies, has existed, except in one or two isolated instances. The hospitals which I inspected at Grafton and Cumberland, in the spring of 1862, were as badly managed, in regard to ventilation, as any which were in operation in the Crimea; in fact, nothing could have been worse than some of these so-called hospitals. In my report† I stated, in referring to one of these buildings, in which the ventilation was entirely disregarded, the police bad, and in which the inmates had but 229 cubic feet of space each, that such a condition of affairs did not exist in any other hospital in the civilized world; and that it was altogether worse than any which were such opprobria to the Allies during the Crimean war. One room in another hospital contained 1440 cubic feet of space, and had nine patients in it.

In extenuation of such a condition, it is to be recollected that the army corps to which the sick belonged had moved,

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* Maladies de l'Armée d'Orient, etc. Appendix, p. 15.

† Two Reports on the Condition of the Military Hospitals at Grafton, Va., and Cumberland, Md. Published by permission.

leaving all the disabled behind them, and that overcrowding was unavoidable. Prompt measures were taken for remedying the evil.

At Grafton a regiment had been encamped, in which the sickness was such as to attract the attention of the general commanding the department. Here a room was found containing 672 cubic feet, and tenanted by eight men afflicted with measles. There were but two windows, and they were closed. Other rooms were not in a much better condition. Proper sanitary measures were immediately taken, and the amount of sickness was at once reduced.

In the civil hospitals of the world instances have not been wanting of the effects due to deficient ventilation. The case of the ward in the City Hospital of New York has been cited. Another instance is almost as striking. The Beaujon Hospital of Paris is situated in one of the most healthy quarters of the city. It consists of four pavilions, identical in size and in the character of diseases received into them. Three of these pavilions were infected with the poison of erysipelas and hospital gangrene; the other was altogether free from it. These conditions had lasted for a long time.

To what cause was this immunity to be ascribed which had continued so many months? The three contaminated pavilions had no ventilation; while in the other, which had remained free from the infection, each patient was supplied with 50 cubic metres of fresh air per hour. Boudin* attributed the existence of these diseases in the one case, and their absence in the other, solely to the state of the ventilation; and there can scarcely be a doubt of the correctness of his conclusions.

In earlier times, the absence of ventilation and the over-

* De la Circulation de l'Eau considérée comme moyen de Chauffage et de Ventilation. Ann. d'Hygiène, 1852, tome xlvii. p. 241.

crowded condition of the wards of hospitals produced the most excessive mortality. In 1786 the Academy of Sciences appointed a commission to inquire into the state of the hospitals, in regard to which there was a great deal of complaint. The following extract, from the report of the Commission in relation to the Hôtel-Dieu, exhibits the deplorable condition of the patients of this institution:—

"They (the commissioners) have seen the dead mingled with the living, wards the passages to which are narrow, where the stagnant air is not renewed, where the light only feebly penetrates, and which are loaded with humid vapors. The commissioners have seen the convalescents mingled in the same wards with the sick, the dying, and the dead; the ward for the insane contiguous to that of the unfortunate patients who have undergone the most severe operations, and who cannot hope for repose in the vicinity of these maniacs, whose frantic cries are heard day and night. A patient coming in is placed in the same bed, and in the same bedclothes used by a patient with the itch, who has just expired. The itch is almost general—it is perpetual in the Hôtel-Dieu—the surgeons, the visitors, the nurses contracting it, either in dressing the patients or in handling their clothes. The patients discharged, who have become affected, take it to their families; and thus the Hôtel-Dieu is an inexhaustible source from which this disease is spread throughout Paris. The operating ward contains those who are being operated upon, those who are to be operated on, and those upon whom operations have already been performed. * * * * Saint Joseph's ward is devoted to pregnant women; the respectable and the depraved are there together, three or four in that state lying in the same bed, exposed to sleeplessness and the contagion from their diseased companions, and to the danger of injuring their infants. The women who have been delivered are also situated three or four in a single bed at different periods of

their recovery. * * * * Independently of all other causes which tend to corrupt the air of this hospital, when it is necessary to change the straw of the beds, as there is no place set aside for this work, it is done in the ward. When the beds upon which so many invalids have reposed are opened, the odor which is exhaled may readily be conceived. In addition, each ward contains several beds of straw for the dying and for those who have soiled their beds. On this straw sometimes as many as five or six are placed. It is simply packed up on the bedstead and covered with a sheet. It is sometimes the case that here, in the midst of the dying and the filthy, the patients, who have not yet been assigned to wards, are placed. It is necessary to witness these horrors, to be convinced of their existence; or rather it would be necessary to fly from them, to remove them from the thoughts, if it were not indispensable to be aware of their existence, in order to make known the terrible condition which prevails, and to rectify it."*

As a general rule, the hospitals of the present day on the continent of Europe are not so well ventilated or kept in as good a condition as those of Great Britain and the United States.

It is perhaps scarcely requisite to dwell at greater length on the absolute necessity of ventilation, in order to prevent infection and to accelerate the recovery of invalids, but the following case is so much to the point that it is brought forward as illustrating, in a striking manner, the dangers of confined air. Dr. B. W. Richardson,† in an essay on scarlet fever, says:—

"At a short distance from one of our villages there was situated, on a slight eminence, a small clump of laborers' cottages, with the thatch peering down on the beds of the

* Des Hôpitaux, etc. Par le Docteur Felix Roubaud. Paris, 1853, p. 79.

† Clinical Essays. London, 1862, p. 92.

sleepers. A man and his wife lived in one of these cottages, with four as lovely children as England ever owned. Not those immortal Angles, whom Pope Gregory recognized as angels in the slave-mart of Rome, were more worthy of our country. But the poison of scarlet fever entered this poor man's door, and at once struck down one of the flock. I had no time allowed me for the practice of any special remedy; but it seemed to me that I had saved the remaining children by obtaining their removal to the care of a grandparent, who lived at a village a few miles away. Some weeks elapsed, when one of these was allowed to return home. Within twenty-four hours it was seized with the disorder, and died with equal rapidity to the first. We were doubly cautious in respect to the return of the other children. Every inch of wall in the cottage was cleaned and lime-washed; every article of clothing and linen was washed, or, if bad, destroyed; floors were thoroughly scoured, and so long a period as four months was allowed to elapse before any of the living children were brought home. Then one child was allowed to return, a boy nine years of age. He reached his father's cottage early in the morning; he seemed dull the next day, and at midnight in the succeeding twelve hours I was sent for, to find him also the subject of scarlet fever. The disease again assumed the malignant type, and this child died, despite all that could be done. I recommended, after this event, that the cottage should be newly roofed; but I am unable to say whether any such precaution was taken, for soon afterward I left the neighborhood for good. I have always believed that in this instance the thatch was the medium in which the poison was retained."

An important question to be considered, when treating of ventilation, relates to the extent to which different strata of the atmosphere of a room become vitiated by the effluvia of the inmates. It was considered that the air changed by

respiration occupied the lowest part of the room, and hence systems of ventilation were devised based upon this supposed weight of the deteriorated air. Leblanc,* however, showed that the air collected at the Opera Comique, after a performance at which a thousand persons were present, and after means had been taken to purify it, contained in the upper part of the room 43 parts of carbonic acid in 10,000 of air, and in the lower but 23 parts in 10,000. This hall was well ventilated by a flue over the chandelier, by which 80,000 cubic metres of air were discharged per hour.

In this case, the very great preponderance of carbonic acid in the upper strata can only be ascribed to the influence of the upward current excited by the ventilator, and to the position of the gas-lights.

Subsequently Lassaigne,† who appears to have studied the subject closely, arrived at results differing materially from those obtained by Leblanc. He found that the air of an amphitheater, after fifty-five persons had been in it for an hour and a half, contained in that collected at a distance of twelve feet from the floor 0·62 per cent. of carbonic acid, while in that taken at the level of the floor 0·55 per cent. was present. It is probable that this small difference was either accidental or due to the ordinary error in the analyses.

According to the law of the diffusion of gases, they mingle with each other without regard to specific gravity. Thus, if a jar of carbonic acid gas be placed under, but in contact with one containing air, in such a manner as to assure free communication of the contents, it will be found that in a short time an interchange will have taken place, carbonic acid will have ascended into the upper jar, and may be detected by lime-water, and air will have descended into

* Op. cit., p. 235.

† Annales d'Hygiène, 1846, tome xxvi. p. 297.

the lower jar, notwithstanding that the specific gravity of carbonic acid gas is more than a third greater than that of atmospheric air.

It is not to be supposed, however, that this commingling is a rapid process; on the contrary, it is very slow, and hence, in a hospital ward, it will always be found that, if care is taken to avoid currents while conducting the experiment, a greater amount of carbonic acid will be found in the lower strata of air than in those nearest the ceiling.

I examined the air of a small room in which three adults had respired for two hours, during which time the windows and doors were closed. I found that the air collected at the distance of eight inches above the floor contained 0·83 per cent. of carbonic acid, or 8·30 parts in 1000; while that collected at a distance of twelve feet from the floor contained but 0·68 per cent., or 6·80 parts in 1000 of air.

With regard to the organic matters given off by respiration and exhalation from the skin, the case is different, as they are always, so far as my observation extends, found in greatest abundance in the upper portion of an apartment in which persons have been recently present. At the same time that determinations relative to the proportion of carbonic acid were being made, I conducted observations in regard to the last-named point, and found that, while a standard solution of permanganate of potassa, placed at a distance of eight inches above the floor, required 865 cubic inches of air to pass through it before it was decolorized, 680 cubic inches sufficed to produce this result at a distance of twelve feet above the floor.

Holes, therefore, made in the floor for the purpose of allowing the vitiated atmosphere to escape, do not effect this object. In the first place, in winter, when the temperature of the ward is always greater than that of the external air, currents will invariably be excited in the opposite direction, and, as the air is not warmed before being distributed

throughout the ward, a reduction of temperature and irregular currents are produced. In the next place, the error has been much too common, that the principal deleterious exhalation from the human body is carbonic acid; and hence the main object has been to remove it from the apartment, ignoring, in a great measure, the far more injurious matters in the upper part of the room.

With reference to the amount of fresh air required for a healthy man in a given time, much difference of opinion has existed. Thus Vierordt fixes the amount at 2½ cubic feet per minute, Dr. Reid at 10 cubic feet, and Dr. Arnott at 20 cubic feet. The first of these is undoubtedly too low, and the last cannot be considered as at all too high. From the nature of the problem to be solved, and from the many influences in operation capable of affecting the result, it is extremely difficult, if not impossible, to arrive at exactness. It may, however, be safely affirmed that, in a ward in which 1200 cubic feet of air are allowed to each patient, this amount should be entirely changed in each hour at the most, and this would require the admission of 20 cubic feet per minute for each patient. An allowance of 30 to 40 cubic feet per minute would, however, be far preferable. The object should be to render the atmosphere of the ward, as nearly as possible, similar in composition, as regards carbonic acid, aqueous vapor, and organic matter present, to that of the external air. In the summer, when the windows and doors of apartments are kept open, it will be no difficult matter to effect this. I found that a room containing 1500 cubic feet, in which I remained six hours with the window and door closed, had the air entirely renewed by leaving the window and door open for fifty-five minutes. The amount of carbonic acid present at the expiration of the six hours was 0·72 per cent., and this was reduced to the proportion existing in the external atmosphere (0·39) in the time stated.

Means of Ventilation.—Ventilation is of two kinds—natural and artificial. Natural ventilation simply consists in the employment of such ordinary means, in conjunction with nature, as are at hand in all dwellings, or which require no special machinery, improving them, and making the most of any advantages to be derived from their use. Thus the proper management of doors and windows, the construction of flues and openings to the external atmosphere, in which currents of air entering the rooms and going out of them are induced, without the employment of special apparatus or moving power, belong to this head. When it is possible to make use of natural ventilation it is to be preferred, not only on account of its cheapness, but also because it is more agreeable and effectual.

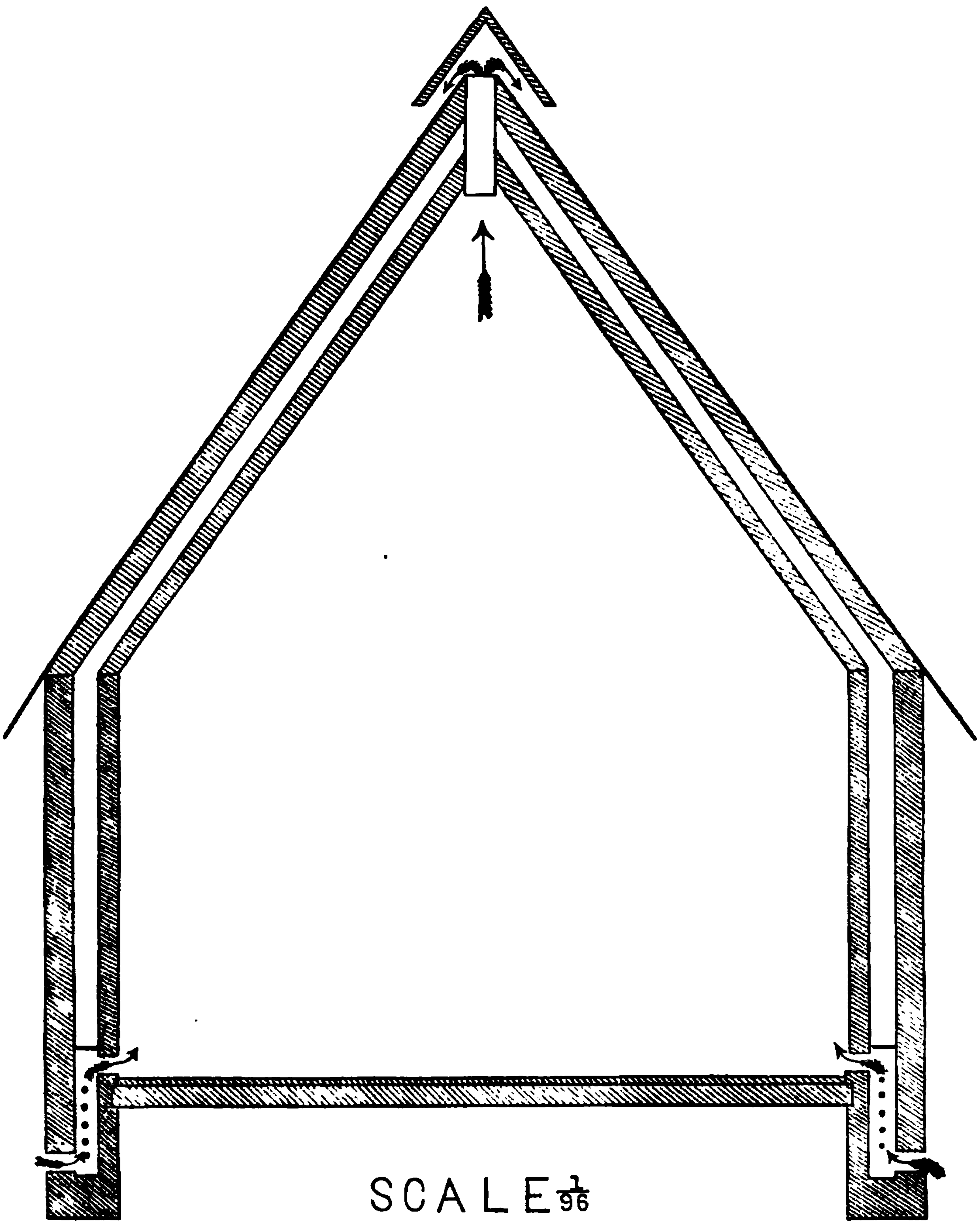
By erecting hospitals according to the pavilion principle, natural ventilation can be employed with great advantage, because three sides of the ward, and sometimes all four, are exposed to the full influence of the atmosphere; and thus through the windows and doors alone fresh air enters, and that which has become vitiated obtains an effectual means of exit. I have seen the air of a room containing 5000 cubic feet entirely renewed in the space of five minutes, by the windows and doors alone, when a moderate breeze has been blowing. In this climate, however, the doors and windows of wards cannot be left open a sufficient length of time, during the cold seasons, to allow such a free circulation of air as is requisite for the health of the inmates of hospitals, as the wards are constantly occupied. But in dwelling-houses the air of all bed-rooms and other apartments, occupied by individuals during night or day, should be thoroughly changed at least once in the twenty-four hours, no matter how cold or inclement the weather may be.

It, however, becomes a matter of necessity to provide for an efficient ventilation of hospital wards by some other plan than windows and doors alone. No better method

than that already described as ridge ventilation can be employed, and with very little additional expense it could be readily made available for all seasons of the year, except perhaps in the extreme northern parts of the country. There is, however, among those who do not understand its action, a prejudice which it is difficult to overcome. In fact, there is more or less feeling against all external openings during cold weather, both on the part of many medical men and nearly all patients. The fear of a draught of air is almost universal among civilized people; the fear of a vitiated atmosphere seldom occurs to them: and yet the bad effects of breathing air contaminated with the emanations from the body, the products of combustion, etc. are infinitely worse than any to be apprehended from a current of air. Even for permanent hospitals built of brick or stone the ridge ventilation is the best that can be devised. Fresh air heated should be supplied in abundance, and the vitiated atmosphere should be allowed to escape through an opening extending the whole length of the ridge. If the air entering the wards of the temporary hospitals were heated by passing over coils of pipes containing steam or hot water, it would be perfectly practicable to retain the great advantages of the ridge ventilation throughout the space. The walls should be double, after the pattern of those figured on page 441, and the ceiling should be arched over, leaving an open space in the center, which might be partially closed by a perforated plate of iron, but which should allow of free communication with the external air. Of course this would necessitate the erection of pavilions but one story high, but this would be an advantage in every respect. The openings in the sides of the ward through which the fresh air is admitted should also be covered with perforated iron plates, and the space between the two walls should contain the heating apparatus. A plate of iron should be placed between the walls, so as to force the heated air to enter the

ward through the opening near the floor. Both the external and internal openings should extend the whole length of the pavilion. The arrangement is shown in section in Fig. 69.

Fig. 69.



SECTION OF PERMANENT RIDGE VENTILATED HOSPITAL.

I cannot conceive of a more efficient system, both of heating and ventilating, than this, nor one which is more simple in its operation.

In apartments in which it is impossible to secure ridge ventilation, a great deal can be done by the construction of flues, by which the foul air is removed from the room. One of the best of these, and one which can readily be adapted to permanent buildings, is that of Dr. Arnott, and which is shown in Fig. 70.

It consists of a metal box inserted into the chimney near the ceiling, and over the inner opening of which a perforated metal plate is placed. When a fire is lighted in the fire-place or stove connected with the chimney, the vitiated air is drawn from the room through the opening. Over the inner face of the perforated plate a piece of silk fastened by the upper edge is placed, so that downward currents into the room, by which smoke would enter, are prevented.

Fig. 70.

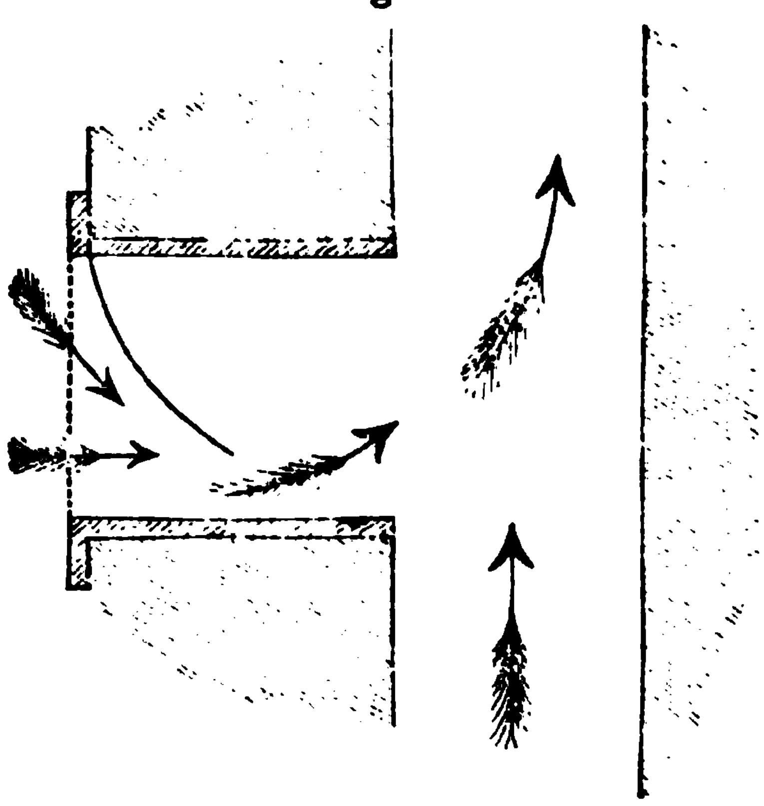
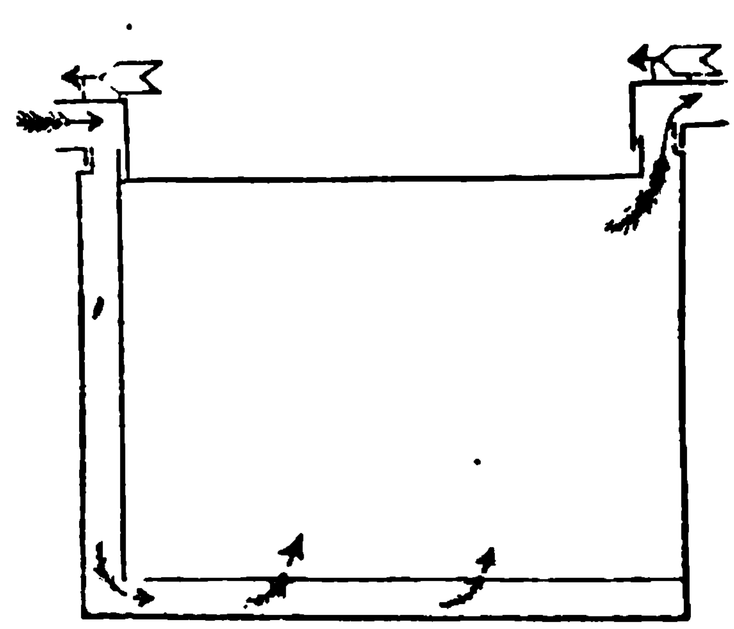


Fig. 71.



A very good means of ventilation, so long as the wind blows, consists in flues through which a current of air is excited by the tendency to a vacuum created by cowls placed at their summits. Or a double arrangement may be made, by which the flues on one side receive fresh air, while that which has become vitiated escapes through them on the other side. An idea of this system will be obtained from an examination of Fig. 71. This plan is only fully effectual while the wind blows.

There are many other plans of natural ventilation which are more or less modifications of those mentioned, and which receive elucidation in the special works on the subject.*

The means for effecting artificial ventilation are also numerous, but are almost always connected with the arrangements for heating. The air may be forced into the room by machinery, or caused to enter it from a source below the level of the apartment through its less specific gravity, in consequence of being heated. This plan only looks to the supply of fresh air; that which has become foul being allowed to escape through the cracks of the windows and doors, the chimney or flues. By another system, the attention is principally directed to the removal of the vitiated atmosphere, leaving the fresh air to find its way in as best it may. Flues are constructed which converge to a larger flue opening to the outside. In this last a fire is kept burning or heat applied in some other way. The consequence is, that currents of air are excited through all the flues, and the foul air is extracted. A third system consists in a combination of both those mentioned. The air is forced into the room by a fan or screw, and heated before its entrance, by passing over pipes containing steam or hot water. It is then extracted through flues communicating with a hot-air chamber, which opens to the external atmosphere. The Episcopal Hospital in Philadelphia is heated and ventilated by this last system, and I can speak from experience of the admirable manner in which both modes are accomplished. The power of extraction produced by hot-air flues is very great, and they may be applied to the ventilation of almost any room with great advantage.

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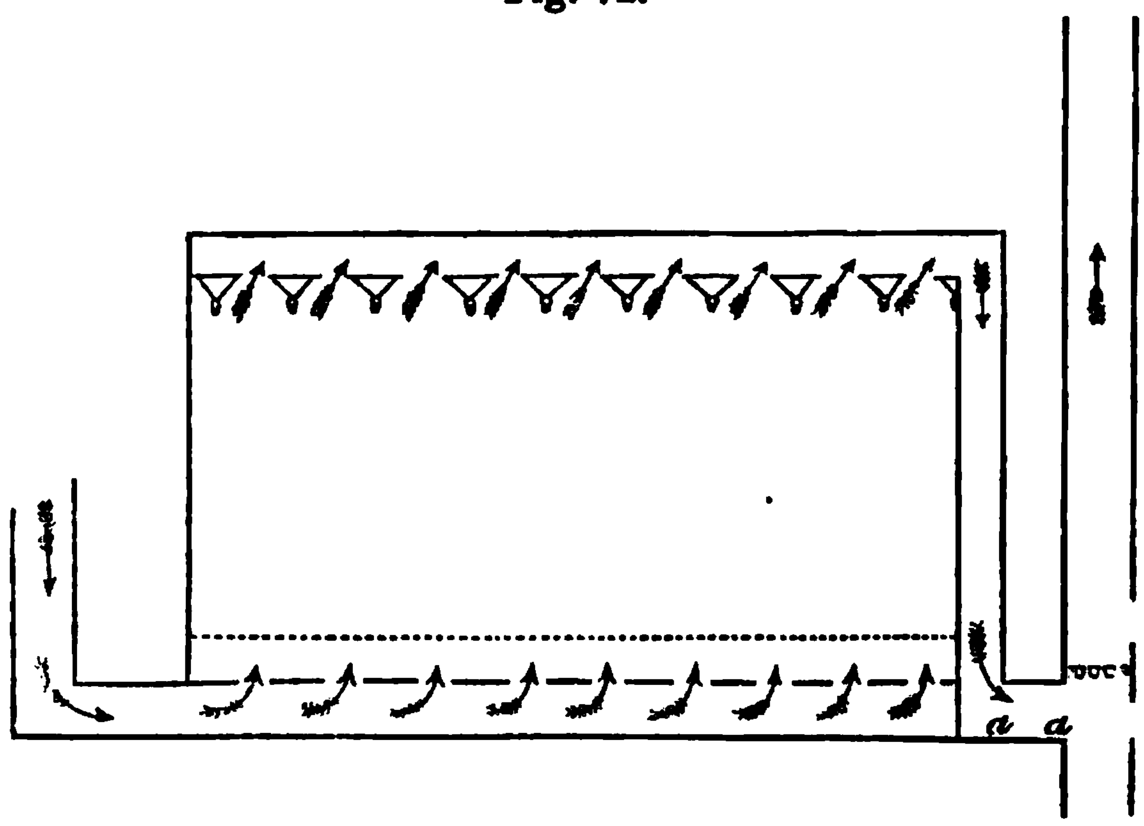
* One of the best works on the subject, to which the student is referred, is the Practical Treatise on Ventilation, by Morrill Wyman, of Cambridge, Mass.

In Fig. 72 the plan adopted by the late Dr. Reid for heating and ventilating the temporary House of Commons

Fig. 72.



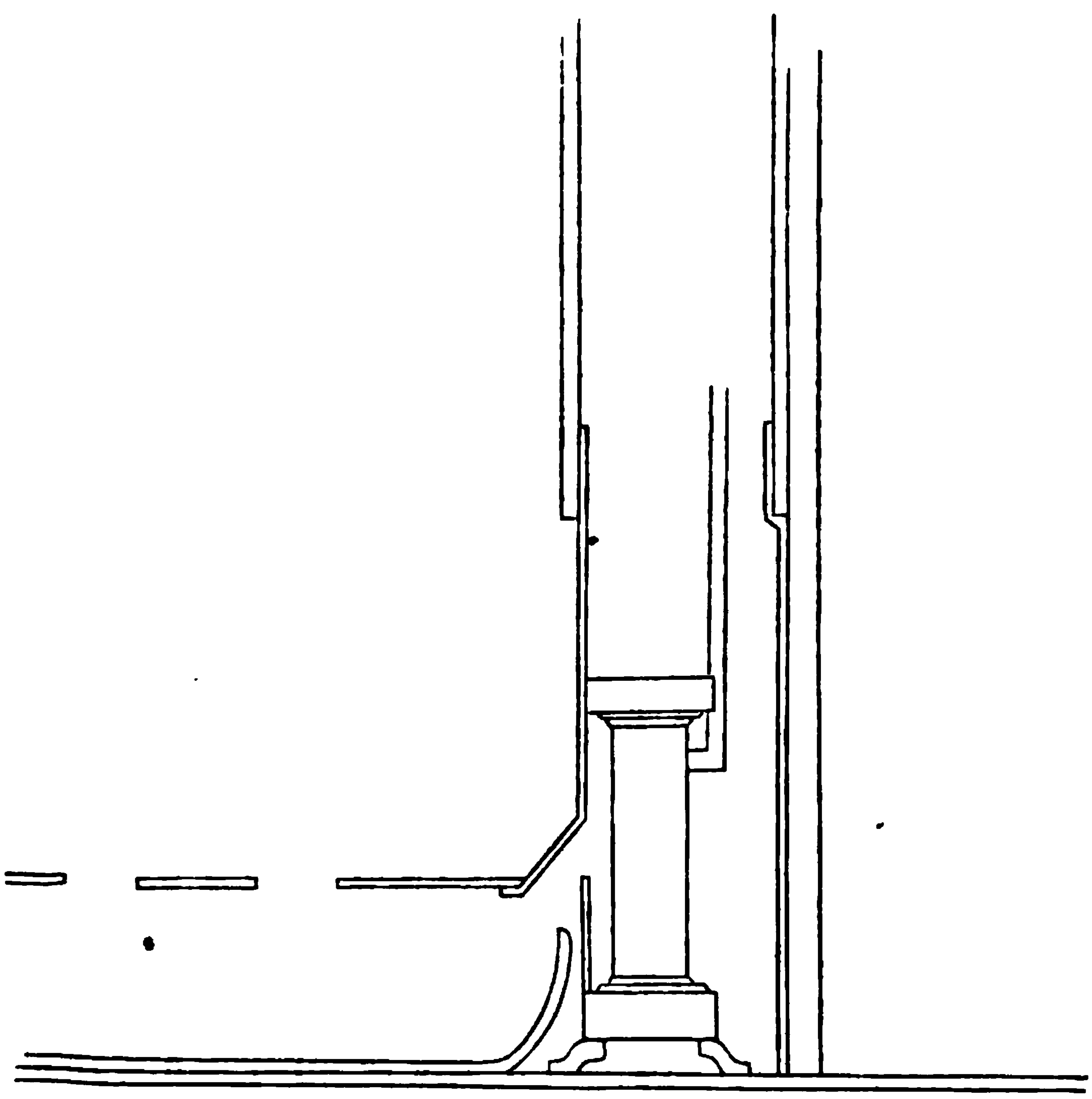
is shown. "The air enters at the turret on the left, and is heated or cooled to the required temperature, by hot or cold water pipes or otherwise, below the floor of the house or in any adjoining apartment. From the main trunk below, the air is either allowed to escape, diffusing itself equally below the whole of the floor, or led away by separate tubes, so as to ascend by the same equal flow, whether entering by numerous small apertures in the grating along the floor or below each individual seat along its whole extent. The row of arrows represents the apertures by which the prepared air enters the body of the house, whether along the floor or below any single bench. Ventilating apertures, placed between each pendant in the roof, remove the air as it rises, which now descends, as is represented, till led into the chimney; the furnace at the bottom, though small, being capable of working the whole of the ventilating apparatus. At *a a* two doors are placed, by opening or shutting which, according to the state of the furnace, the velocity of the current from and into the house may be increased or diminished almost to any extent in an instant. The furnace is

worked by coke alone, the doors *a a* being shut on kindling it, and air admitted for a short time by the ash-pit doors.

"Delicate but large thermometers, placed within the house, and also in the main ventilating pipes as they enter and leave it, guide the attendants, and are at the same time a complete check upon the regularity with which every part of the operation is carried on."

Fig. 73 shows the arrangement adopted in some of the United States Army hospitals for ventilating the latrines. A strong downward current is excited by the stove, and all the effluvia carried off.

Fig. 73.



It would be very easy to adduce many other plans of ventilation by artificial processes, but it is believed that

enough has been said to indicate the principles by which they are governed. The main object aimed at has been to leave no doubt on the mind of the reader relative to the noxious character of air which has become contaminated by animal effluvia or by the several processes of illumination and heating in use. If success has been attained in this direction, the means of securing a supply of fresh air and of freeing the inmates of a hospital from that which they have vitiated will be sufficiently apparent from what has been said on this part of the subject, or if not, the main points will have been so far rendered evident that the intelligent medical officer will be able to apply the principles to practice. And this concludes what we have to say with special reference to hospitals. If the limits or character of this work permitted, a great deal could be written relative to the principles which should prevail in the management of military hospitals. Some of these will of course be referred to under the heads of Food and Clothing, but such as relate to the discipline of hospitals, and the duties of the officers and attendants, do not properly come within the scope of a treatise on hygiene.

CHAPTER XIX.

BARRACKS.

Much which would have been written relative to barracks, in an essay specially devoted to their consideration, has been brought forward under the several heads relating to hospitals, so that there is little to be said in regard to them without going over ground already traversed. With reference to their construction, the principles do not vary

essentially from those applicable to hospitals. From the fact, however, that they are inhabited by well men, who are not confined to them day after day as are patients of a hospital ward, so large an allowance of superficial and cubic space as is given to the sick is scarcely necessary. In permanent barracks 600 cubic feet of air, if the ventilation is properly looked after, will be found ample, and in temporary structures, ventilated at the ridge, 400 to 500 will be sufficient.

As measures of health, every barrack should be provided with bath-rooms, ablution-rooms, and mess-rooms. The dormitories should be of such a size as to contain a company with the space above mentioned. Fifty square feet should be allowed to each man. The windows and doors should be large, and the barrack should be surrounded with a veranda, in which the men can walk during inclement weather.

The barracks at Fort Riley in Kansas are the best I ever saw. They are built of stone, and are two stories high. In the lower story are the kitchen, mess-room, ablution-room, orderly-room, store-room, etc. The whole of the upper floor is the barrack-room. Each building is a unit, and is intended for the accommodation of one company. The barracks occupy two sides of a square, and the officers' quarters the other two sides. The intervals between the buildings are, however, wide enough to allow of a free circulation of air.

CHAPTER XX.

CAMPS.

CAMPS are ordinarily formed of tents—unless a more permanent character is designed for them than can be obtained from such structures, when sheds or huts are built for the purpose of more effectually sheltering the troops. Camps are in their very essence unhealthy; they are even more so than large cities, because less attention is paid (oftentimes necessarily) to those points—such as sewerage, drainage, heating, ventilation, etc.—which exert so great an influence over the health of the inhabitants. At the same time there is no positive reason why many measures which are now frequently overlooked should not be carried out, with the effect, which would be sure to follow, of improving the health, and, consequently, adding to the efficiency of the troops.

Tents are generally made of cotton-duck, which, on account of its greater imperviousness to water, and cheapness, is preferable to linen or hemp. Great variety prevails in regard to form. The wedge-shaped tent, some years since, was entirely used for the men, and the wall tent for officers. Latterly, however, the wedge-shaped tent has fallen into disuse, having been superseded by the Sibley tent, which in many respects is far preferable, though in others falling short of what is required in a good tent.

The great advantages of the Sibley tent are that it admits of being readily warmed by an open fire, and of efficient ventilation, in winter. It is of conical form, with an opening at the apex, which is partially covered by a movable

cowl, so arranged as to be easily shifted, according to the direction of the wind. Around the opening an iron ring is attached which is connected to a central pole by three chains. This pole supports the tent, but does not extend to the ground—a tripod, the legs of which are hinged, being affixed to the lower extremity. By opening or closing the legs of the tripod, the tent is elevated or lowered. The principal objection to be urged against the Sibley tent is that as there is no perpendicular wall to it, the edge is directly attached to the ground, and cannot be raised so as to allow of a free circulation of air through the tent. If the Sibley tent was furnished with a wall three or four feet high, and the conical roof instead of touching the ground was connected with it by cords, the wall could be raised and the air thus caused to pass through the tent. With this addition the tent would be as perfect as any tent could be. As it is, it fulfils the requirements of health better than any other in use.

The Sibley tent is not an original idea. The Camanche lodge is constructed upon the same principle, and is even superior to it in the means of support. The Sibley tent is occasionally supported in permanent camps by three poles fastened together at one end and separated so as to form a tripod—the tent being hung from the apex. In this way more room is obtained.

The Sibley tent is intended for fifteen infantry soldiers or thirteen mounted men. In permanent camps these numbers should be reduced to twelve and ten.

The *bell tent* is also in use in the army, and is the next best to the one just described. A window is cut in one side near the top, which can be closed by a canvas flap. In this way ventilation is secured.

The *officers' tent* is square, and has a wall four feet high, which can be raised all around. It is also supplied with a fly, by which the heat of the sun and rain are more effectually kept from entering.

The *hospital tent* is made of heavier canvas than any of those mentioned. It is 15 feet square, has a wall 4½ feet high, and is 12 feet high to the ridge. It is furnished with a heavy fly. It is open at both ends, and is so arranged that two or more can be joined together, forming a continuous ward.

Each tent will accommodate comfortably six men in bedsteads, three on each side, leaving a passage in the center of 2½ feet in width, and the same distance between the beds. No special means are provided for the escape of the foul air except by raising the wall and opening the flaps in the ends. It would be well if windows, capable of being closed in very inclement weather, were cut in the roof. These would be at all times covered by the fly, but would allow of the escape of vitiated air.

In a hygienic point of view, tent hospitals are the very best of all, and during warm weather should be preferred for all classes of patients. Even in the midst of winter, they can be made exceedingly comfortable by stoves, and can be ventilated by the plan a description of which is given on page 357. They should always be floored with boards, loosely put down, so as to admit of their being removed, and the ground beneath aired occasionally. The common tents of all permanent camps should also, if possible, be floored after the same manner.

In pitching tents, the principles which have already been laid down, under the heads of Soil and Locality, should prevail. Too much care cannot be taken in the selection of the ground, and in providing such a location as will admit of the troops supplying themselves with good water and wood. A trench, eight or ten inches deep, should be dug around each tent, and should lead, with the trenches from the other tents, into a larger one for each street, capable of allowing the water to flow from the camp-ground. Tents should, in all permanent encampments, be frequently

struck, and the ground upon which they have been pitched thoroughly aired.

The inside of tents should never be excavated. Nothing is more productive of zymotic diseases than the practice, which too frequently prevails, of cutting the ground down within the tents, so as to leave a wall of earth as a barrier against the entrance of fresh air, and as a most effectual absorber of the effluvia from the bodies of the inmates. It is quite recently that a medical inspector of the army reported that a regiment, which went into a camp composed of excavated huts, was attacked immediately with typhus fever. They were at once abandoned, new huts without excavations were constructed, and good health once more prevailed.

Huts are often built by the troops when there is a probability of the camp being somewhat permanent. They should be large enough to contain 20 men, with 400 cubic feet and about 40 feet superficial area per man. They should be ventilated at the ridge, and should be arranged after the same plans and built generally in the same manner as those already specified for hospitals. The ground for huts should be thoroughly drained—a porous soil being, for the reasons previously stated, preferable to any other—and they should be so situated as not to be subject to overflow from the water drained from higher ground in the vicinity.

Arrangement of Tents and Huts.—No regulations in regard to the arrangement of tents, since the adoption of the Sibley tent, have been published. The present regulations are applicable only to the wedge or A-shaped tent. For a regiment of infantry on the peace footing, 80 of these were allowed, 6 men being the complement for each. The extent of surface covered by the men's tents was 48 yards by 400 yards, equal to 19,200 square yards. Each tent had therefore an allowance of 215 square yards, which was equivalent to 14,408 tents to a square mile, which, as each

tent contained 6 men, gave a total population, to a camp pitched according to the regulation, of 86,448 to the square mile.

In regard to the overcrowding of men in camps, the same remarks are applicable which were made on the subject when hospitals were under consideration. It is no matter of astonishment that soldiers exhibit a higher sickness rate than civilians, when the fact is brought to mind that all camps are more densely populated than many large cities. The regulation camp above referred to gives a density of population of 86,448 to the square mile, while London has but 50,000, Birmingham 40,000, Philadelphia 45,000, etc. The following remarks from the Report of the Commission on Barracks and Hospitals, so often referred to, are so appropriate, that I have not hesitated to quote them in full:—

"As regards the arrangement of tents and huts, it may be laid down as a general rule that the more space allowed between them for ventilation, the more healthy will the force be; but the area over which it is possible to spread a force must necessarily depend on the size of the ground and on the nature of the service. Some general principle should nevertheless be adopted in dealing with the question. It has been shown in the Report of the Royal Commission on the Sanitary Condition of the Army that the Quartermaster-General's instructions, issued at the commencement of the Crimean war, authorized densities on the camp surface equal to 347,000, 348,000, and 664,000 inhabitants per square mile. The lowest of these densities is double that of the most densely populated district in England. It includes not only the ground actually covered by tents, but all the open spaces in the camp. The ground actually covered by tents in these plans of encampment gave a density of population equal to 1,044,820 per square mile.

"The influence on health of surface overcrowding in

towns is now well known, and there cannot be a doubt that surface overcrowding in camps is a common cause of camp diseases. A camp is a temporary town without paving or proper drainage. It is only by paving and drainage that the deleterious influence of surface overcrowding in towns can be reduced to a minimum. But paving and drainage cannot be carried out to a sufficient extent in camps to enable the surface to be crowded, and therefore as large an extent of space should be given as the nature of the ground or of the service will admit.

"At the time of the Health of Towns' Inquiry, it was found that the approximate density of population on the built area of five of the principal towns of England was as follows:—

Towns.	Inhabitants per square mile.
Leeds	87,256
Metropolis (London)	50,000
Birmingham	40,000
Manchester (township)	100,000
Liverpool (parish)	138,224

"It was, moreover, found that the proportional annual deaths from fever in these towns increased with the density.

"In the report of the Royal Commission on the Sanitary State of the Army, the following examples are given of the more densely peopled districts of the metropolis:—

District.	Inhabitants per square mile.
St. James, Westminster	144,008
Holborn	148,705
St. Luke	151,104
Strand	161,556
East London	175,816

"All these examples, drawn from towns, occur in places where paving and draining have been more or less carried

out, and where, nevertheless, the influence of surface overcrowding on health is obvious, on a comparison being made with less crowded districts. If we compare any of these densities with the authorized densities for camps, which have neither drainage nor paving, given above, we shall be able to form some estimate of what is likely to be the influence on health of surface overcrowding in camps.

"Assuming a square mile = 3,097,600 square yards, and 15 men to a tent, as our units of comparison, the following table will give the surface area per tent for different densities of population per square mile:—

Number of square yards per tent.	Number of tents per square mile.	Number of troops per square mile.
50	61,952	929,280
100	30,976	464,640
150	20,650	309,760
200	15,488	232,320
300	10,325	154,880
400	7,744	116,160
500	6,195	92,928
600	5,162	77,440
700	4,425	66,377
800	3,872	58,080
900	3,441	51,626
1000	3,097	46,464
1100	2,816	42,240

"It appears from this table that to allow 350 square yards per tent would give a density per square mile equal to that of Liverpool; about 450 square yards per tent would give a density equal to that of Manchester; and 900 square yards per tent would give a density equal to that of the built part of the metropolis; and to reduce the surface density to that of Birmingham would require also 1200 square yards per tent to be allowed.

"The Quartermaster-General's Regulations referred to would, if rigidly carried out, allow no more than from about

70 to 134 square yards per tent; but in estimating the probable effect of this area upon health, we must revert to the fact already mentioned, that the town districts used in the comparison are paved and drained, while camps are not.

"As already stated, the number of troops to be placed on a given area must be determined by local circumstances; but the tables we have given will be useful in enabling a correct judgment to be formed as regards one very important element in the sanitary state of camps, namely, density of population.

"The manner of arranging tents is of importance to health as well as to cleanliness. Battalion camps are not unfrequently arranged in such a way that the tents touch each other, except where a narrow passage is left between the rows for access. A camp so arranged can never be clean nor healthy. In cleaning out one row of tents, the dust is merely driven into the adjoining row. Thorough ventilation is impossible, and as regards the unhealthiness of such an arrangement, every army medical officer is in the habit of recommending the spreading of tents over a larger surface, as one of the most efficacious means of arresting epidemic disease in camps, a sufficient proof of the relation between camp epidemics and surface overcrowding.

"Battalion tents should never be arranged in double line; short single lines are best. The tents in line should be separated from each other by a space at the very least equal to a diameter and a half of a tent, and the farther the lines can be conveniently placed from each other the better."

Of course these remarks are equally applicable to the huts, which the troops generally build in cold weather. My own observation has satisfied me that they are invariably placed too close together, and that but little attention is paid to ventilating and draining them. An instance of the evil results of excavating the floor of huts has already

been given; one equally striking illustration of the consequences of banking earth against the sides is afforded by the camp of the 79th Highlanders, as it was established in the Crimea:—

"Part of this regiment occupied a range of wooden huts and tents immediately under the steep descent from Marine Heights, at an elevation of about 550 feet above the level of the sea. The ground was a porous, sandy loam, with a considerable water-shed above it. In preparing the ground, sites for huts had been dug out of the slope, and the earth was heaped up against their sides. The surface was not sufficiently drained, and the huts were not properly ventilated.

"The remaining part of the 79th were, for special military reasons, encamped 100 feet lower down, where the ground was soft and wet. The ground sloped rapidly toward this part of the camp, and, from the configuration of the surface, the drainage from Marine Heights above was concentrated in a hollow, within which a number of huts had been erected for the men more immediately engaged in the defense of the works, which passed close to the doors. A few of these lower huts were erected above the hollow, and with a good natural drainage.

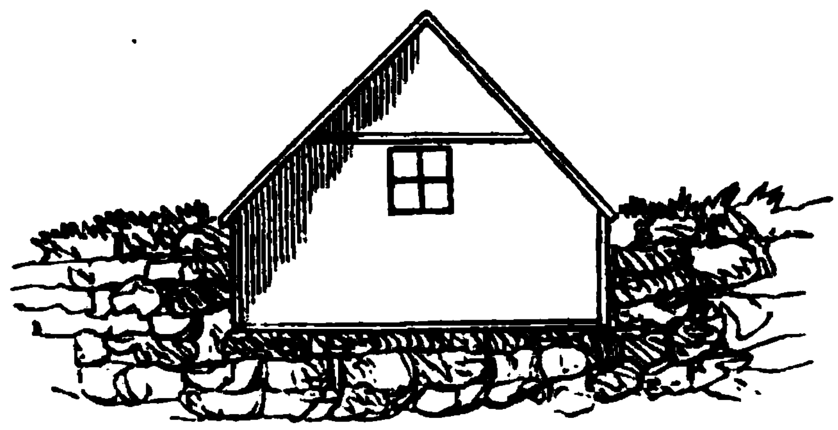
"The whole of the ground was wet and traversed by superficial drains, and it had, moreover, been extensively turned up in constructing the works. In erecting the huts, the space cut out of the slope was just sufficient to hold the hut, and the earth was left in contact with the boarded sides for two or three feet in height."

Fig. 74 shows a transverse section of the upper end of one of these huts.

"The attention of the Commissioners was first specially directed to this part of the camp by a representation from Sir Colin Campbell that fever had been very prevalent among the troops occupying it. On the 13th of April,

1855, the Commissioners met Sir Colin Campbell by appointment, and proceeded to make a careful examination into the circumstances.

Fig. 74.



"It appeared that shortly after the ground was occupied, in the end of October, 1854, zymotic diseases, chiefly diarrhœa, with a few cases of fever and cholera, occurred among the men. From the week ending 31st October until the date of our inquiry, 80 per cent. of the sickness in the regiment had been occasioned by zymotic diseases. Diarrhœa cases were most numerous until the week ending January 16th, 1855, and there were comparatively few fever cases before that date. From the 16th January till the 18th April, the time when the measures recommended by the Sanitary Commission were taken, above 74 per cent. of the total sickness had been caused by fever. During the week ending April 11th, out of 64 cases, 60 were from fever. The type of fever was remittent, passing into the typhoid form, strongly marking the causation. At the time fever prevailed, the other forms of zymotic disease had nearly disappeared.

"There had been some fever in the range of huts under Marine Heights, but the majority of the cases were confined to the huts on the wet ground close to the works. There was little or no fever in tents in the vicinity.

"In addition to the topographical defects already mentioned, we found the floors of the infected huts very damp; and on removing the boarding, the surface of the ground

beneath was found covered with the threads of fungi, and the atmosphere in the huts had the peculiar odor and dampness usually experienced on going into an underground cellar.

"So wet was the sub-soil that water was found under one of the angles of a hut. The men slept on the boarding hardly raised above the ground, and breathed the damp malarial atmosphere arising from it. The cubic contents of the huts were 3645 feet, and allowing twenty-five men to a hut, the cubic space per man would be about 146 feet. The ventilation was insufficient, and, under all the circumstances, the huts were overcrowded."

The Commissioners very properly recommended that either the troops should be removed or the sanitary condition of the huts improved, by digging away the earth banked against their sides, and draining each hut separately by a trench extending around it, and about a foot below the floor of the hut; and that the huts should be ventilated at the floor and ridge, and the number of men in each reduced.

Lord Raglan at once proceeded to act on these suggestions, and the consequence was that the fever immediately abated, and the condition of the sick commenced to improve.

Some of the huts—those on the wet ground—were vacated by the 79th Regiment; about a month afterward the 31st Regiment arrived and took possession of them. At this time the strength of the regiment was 873. On the 1st of June a case of cholera occurred, and between this date and the 16th there were 34 deaths from cholera and a great number of cases of diarrhœa. The company most severely affected occupied the bad huts. On moving this company higher up, the disease abated.

The 31st left the huts on the 16th of June, and they remained vacant until the early part of the following September, when they were occupied by three companies of the

Royal Artillery, a fourth company being encamped on dry ground outside of the lines.

On the 7th of October cholera broke out among the men inhabiting the huts on the wet ground. Seven deaths occurred from the disease, and diarrhœa became very prevalent. Finally, the medical officers ordered all the bad huts to be taken down and rebuilt on better ground higher up. They were reoccupied by the same men, and one more death from cholera took place before the disease disappeared.

The fourth company, which was in camp outside the lines, but only a short distance from the affected huts, escaped the disease altogether.

The ground upon which the huts had stood was examined after their removal, and found perfectly saturated with water.

A more instructive instance of the impropriety, not to say criminality, of requiring men to inhabit buildings so situated as the huts on the Marine Heights, is scarcely to be found, and should be a warning which at this time we should not hesitate to heed. A persistence in violating the laws of hygiene is certain to bring disaster, and yet so many act as though the consequences were of little importance, or even as though there were no consequences at all.

Latrines.—The latrines should be situated at least 150 yards from the tents. This is the distance required by the General Regulations of the Army, and is not at all too great. They should be situated to leeward of the camp. A deep and narrow trench should be dug for the purpose; if too wide it will require more earth to cover the excreta, and will, moreover, expose a greater surface from which the noxious effluvia will be given off than if it is narrow. Every evening the accumulations of the day should be covered with at least a foot of earth. As we have seen, earth readily absorbs the matters which are given off by

putrefying substances. After the trench has become filled to within three feet of the top it should no longer be used, but should at once be filled up with earth.

Latrines should not be made over streams of water or in the vicinity of springs or wells. In either case the water will become contaminated, and serious disease may be the result.

Police.—In all camps the most complete attention should be given to cleanliness. The streets should be swept regularly every day, and the dirt carted away. Tents should be thoroughly aired by opening the doors and raising the walls after the men have left them in the morning. All bedding should likewise be exposed to the air every day unless the weather is such as to prevent it. Straw which has been used a week should be replaced by fresh—the old being burned.

Slaughter pens should be placed at a considerable distance from the camp, and in such a position that the effluvia cannot incommode the troops. They should often be purified with chloride of lime or other disinfectant. The offal should be burned.

Horses and other animals should not be kept near the men. In cavalry camps other reasons than those of a sanitary nature require the horses to be so placed as to be within easy reach in case of necessity. The picketing-ground should always, however, be to leeward of the camp. Dead animals, dung, and other refuse should be burned.

Medical officers have it in their power to do much toward improving the hygienic condition of camps and adding to the comfort of the men. It rarely happens that commanding officers refuse to listen to their suggestions, if made in good faith and based upon the principles of common sense. Baron Desgenettes, who was the principal medical officer of the Army of Egypt, relates that one morning at daybreak Napoleon found him examining the latrines. "What in

the devil are you doing there?" said the general. "I am attending to my duty," replied Desgenettes, "and I expect on this occasion to find something for your next general order." In the evening the general sent for him, and questioned him more particularly in regard to the incident of the morning. Desgenettes explained to him fully the danger of the exhalations from latrines, and that he was anxious to find some means of neutralizing their bad effects. Bonaparte listened with attention, and when the baron had finished expressed his satisfaction with the devotion to duty and care for the health of his troops by which Desgenettes was actuated.

There are many other points than those specified connected with the hygiene of camps, which will receive attention under the heads of Food and Clothing.

With reference to the health of the large camps which have been established by the United States Army since the commencement of the present rebellion, the reports which have been received from medical directors and military commanders go to show the excellent sanitary condition which has generally prevailed. There have been some exceptions, but it is a matter of congratulation that they have been few. In the Army of the Potomac during the last winter the sick at one time formed less than six per cent. of the whole force, and never exceeded eight per cent. These ratios are much less than ever before met with in an army of such a size engaged in active operations. In the English and French armies in the Crimea the proportion was far greater than this, and even in camps established during peace, and with every opportunity of paying especial attention to sanitary measures, a more favorable condition has rarely been presented.

CHAPTER XXI.

FOOD.

As a necessity of existence, food is only second in importance to atmospheric air. A few moments deprivation of one or a few days of the other produces death. The tissues require renovation, and the heat of the body must be maintained. For these two objects food is taken. These only are the physiological uses. Another incentive to the ingestion of food, the gratification of the sense of taste, is mainly the result of civilization. When we eat to preserve life, it rarely happens that disease is the consequence; but when the indulgence of the appetite is based on sensual gratification, disorder of almost every function of the body may be produced, and even structural alterations of organs may in time result. It thus happens that from yielding to the temptation to eat more than the system requires to maintain it in healthy action, or of those things which experience has shown to be injurious, man is more subject to disease through the influence of food than from any other cause.

The essential qualities of food are, first, that it shall contain those substances which are capable of nourishing the tissues or of entering into such combinations as will result in the production of heat; and second, that the nutritious material shall be in such a form as will admit of its being digested and assimilated by the organs whose office it is to prepare the ingesta for the purposes of the organism. There are many substances which are easily digested but yet do not possess such a composition as to render them

useful to the system, either as histogenetic or heat-producing materials; and, on the other hand, others, which if we regarded them simply from the stand-point of their composition, would be pronounced as highly nutritious, or as excellent calorifacients, but which experiment has demonstrated are absolutely useless as food, from the fact that they are incapable of being acted upon by the digestive juices. To this last class belongs gum, a substance analogous in composition to starch and sugar, both useful articles of food; yet gum when ingested into the stomach undergoes no change in the alimentary canal, but is excreted in the same form as it possessed before its entrance into the body. The experiments of Boussingault, Frerichs, Bondlot, Lehmann, and myself* are perfectly conclusive on this point.

Under the head of food are included not only the substances which are eaten, but also those which are drunk. Liquids are as much entitled to be considered food as are the various solid substances to which the designation is ordinarily restricted.

The most natural division of food would be into animal, vegetable, and mineral, for all three kingdoms unite to furnish man with his sustenance. In cold climates he lives almost entirely on animal and mineral food, in hot ones on vegetable and mineral substances, in temperate climates he draws his food from the animal and vegetable kingdoms of nature, and mixes with it a due proportion of inorganic matter. Thus we may regard the mineral substances—under which head water, salt, iron, etc. are to be included—as the most generally necessary for the maintenance of life.

But such a classification is not that which affords us the clearest ideas relative to the character of the food of man.

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* Physiological Memoirs, p. 137.

It gives us no indications in regard to the composition of the substances which constitute his diet, or of the purposes which they serve in the economy, and therefore a more philosophical division, based upon chemistry, is necessary. We know that no two articles of food are exactly alike, either in composition or in their effects upon the system; but it has been ascertained that the several alimentary substances can be arranged in groups, the members of which fulfil analogous uses in the economy, and which possess some one or more striking features in common.

It is extremely difficult to make any classification of the substances taken as food which is not open to objection. It has been attempted on the basis of their supposed physiological destination, and thus they were divided into the histogenetic and the calorifacient substances; the one going, as was imagined, solely to the formation of tissue, and the other entirely to maintain the heat of the body. More extended observation has, however, shown that no such exclusive division exists, as those substances which are pre-eminently tissue forming also aid in producing heat, and those which are mainly calorifacient in their action likewise contribute to the formation of tissue.

It is important that this division, which, through the influence of Liebig and his followers, has become familiar to most well-read persons, both in and out of the medical profession, should be altogether set aside as one that is calculated to lead to very erroneous theories and practices. If there is any one substance which is pre-eminently tissue forming it is albumen, and yet, as I have shown by positive experiment, it is entirely possible not only to form tissue with this substance alone, but also to maintain the animal heat at its normal standard, no other article of food being taken into the system except water. On the other hand, fat is, from its composition, one of the most powerful agents in the production of animal heat; but, as observa-

tion shows, fat is essential to the formation of the primary cells from which all tissues result.

A more convenient classification is based upon the predominance in the substances in question of some one or more elements which give an individuality to the group of articles in which they are found. This division, which was that proposed by the author* several years since, although by no means perfect, is, all things considered, the most available for our present purpose. In accordance with it there are—

1st. The nitrogenous substances, characterized by the presence of nitrogen, such as albumen, musculin, casein, gluten, etc., which principally are of use in forming tissue, but which also aid in sustaining the heat of the body.

2d. The fats, composed of carbon, hydrogen, and oxygen, the carbon being in larger proportion and the hydrogen in excess of the quantity required to unite with the oxygen to form water. These substances are pre-eminently calorifacient, but are essential to the formation of tissue. They are sometimes called hydrocarbons.

3d. The amylaceous and saccharine groups or carbohydrates, which are also composed of carbon, hydrogen, and oxygen, the two latter, however, being present in the proportion necessary to form water. The substances of these groups are also mainly useful for the production of heat, but likewise enter into the composition of some of the tissues.

4th. Inorganic substances, such as water and certain minerals.

5th. Substances which, perhaps, strictly speaking, are not food, such as alcoholic liquors, coffee, tea, spices, etc., but which are of service either as promoters of digestion, as

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* On the Nutritive Value and Physiological Effects of Albumen, Starch, and Gum, when singly and exclusively used as Food. Prize Essay of American Medical Association, 1856. Also Physiological Memoirs, p. 68.

retarding the too rapid waste of the tissues, or as tending to increase the heat of the body, either by their own oxidation or by their peculiar action on the nervous system. These articles have been designated "accessory food," a term which very well expresses their functions in the economy.

All the alimentary substances used by man as food are comprised within the above-named groups. We shall therefore consider the ingesta under the five heads specified, namely, the nitrogenous aliments, the fatty aliments, the amylaceous and saccharine aliments, the inorganic aliments, and the accessory aliments. But in so doing, it would not altogether answer the purpose we have in view if we should stop here. It is important that the nutritive value of the various articles of food, as they are used by man, should be understood. Thus many substances are compound, to the composition of which two or more of the above-named classes contribute. Bread, for instance, is nitrogenous, amylaceous, and inorganic. Indian-corn contains, in addition, a large amount of oil; and all the nitrogenous articles of food have mineral substances as essential constituents. After the consideration of the elementary groups, into which we have divided the ingesta, we shall therefore point out the physiological and hygienic relations of the more important compound articles of food which are used by man, the adulterations to which they are subjected, the means by which their purity can be ascertained, and the proper methods to employ in cooking and otherwise preparing them to be eaten.

CHAPTER XXII.

ALIMENTARY PRINCIPLES.

THE alimentary principles are those which, as has been said, give rise, by their union, to the various substances which are used as food. It does not often happen that they are ingested in their uncombined form, as they are neither in such a condition generally palatable nor in the best state to be acted upon by the digestive juices. Nature has so mingled them as to adapt them to the taste and render them better fitted for the purposes of life; and man, as if by instinct, mixes them so as to form compound substances capable of fulfilling the requirements necessary in food. But by pointing out the peculiarities of the several alimentary principles, we shall be better enabled to form a correct opinion relative to the compound substances into the constitution of which they enter.

THE NITROGENOUS ALIMENTARY PRINCIPLES.—As denoted by the name, the aliments of this division are those which contain nitrogen. Several principles have been distinguished by chemists as belonging to this class, but they can all be reduced to three—albumen, casein, and gluten—and they are found both in the animal and vegetable kingdoms. Thus, for example, emulsin is identical with the albumen of animal tissues, legumin with casein, and fibrin with gluten. In addition to nitrogen, they contain carbon, hydrogen, and oxygen, together with small quantities of sulphur and phosphorus. Mulder suggested that they were all modifications of a common principle, protein; but the existence of this body has never been satisfactorily

established, though the theory has given the designation of proteinaceous to the substances in question.

The nitrogenous principles differ from those of the other classes, in the fact that they undergo *putrefaction* when subjected to certain conditions. By this process they are resolved into carbonic acid, ammonia, water, and compounds of sulphur, phosphorus, and hydrogen, characterized by the offensiveness of their odors and by the deleterious effects which they are capable of producing on human health.

In order that putrefactive decomposition shall occur, an *elevated but not too high a temperature* is necessary. At 32° the process is altogether prevented, and at points above 100° the substance rapidly becomes dry through the loss of its water, and, in the condition which results, may be indefinitely preserved. Advantage is taken of both these facts to preserve articles of food. Meats of various kinds are frozen, and can then be transported to any distance and kept for any length of time. South-down mutton is brought from England to New York without the loss of any of its good qualities.

In the western prairies buffalo meat is cut into thin strips by the Indians and emigrants, and exposed to the full heat of the sun for several days. After it is thoroughly dried it may be kept for any length of time without undergoing putrefaction, if it is preserved from the influence of moisture. Bread can also be kept, when deprived of the greater part of its water by being exposed in an oven to a high heat. Crackers and hard bread are prepared in this way.

It is thus seen that *moisture* is also essential to putrefaction. All the nitrogenous substances used as food can be readily kept for years if they are deprived of their water.

Putrefaction is prevented by excluding the substance from the action of the atmosphere. This fact is taken advantage of in the preservation of articles of food in

hermetically sealed cans. Meats, milk, fruits, etc. are thus kept sweet for years.

Putrefaction can also be prevented by the addition of sulphite of lime or soda to any fluid nitrogenous substance which it is desirable to preserve. A few grains of either salt, not sufficient to be detected by the taste, will arrest decomposition. The first act in putrefaction is the liberation of oxygen, which seizes on a portion of the sulphite and converts it into a sulphate. So long as any sulphite remains unchanged, the substance will be preserved from putrefaction.

Salt, sugar, corrosive sublimate, arsenic, chloride of zinc, chloroform, alcohol, spices, and many other substances prevent putrefaction, mainly by coagulating the albumen and abstracting the water from it. We shall remark further upon the methods of preserving food in subsequent chapters.

The nitrogenous principles admit of easy digestion and assimilation, from the fact that they require little alteration to be converted into tissue. Though they differ in physical characteristics and apparently in chemical constitution, it is probable that they are, as asserted by Mulder, essentially one substance.

I have not included gelatin among the nitrogenous principles, for the reason that, though containing nitrogen, it is not an original formation, being derived from certain animal tissues by the action of boiling water. It is produced under various forms, according to the character of the substance acted upon. When taken as food it is at once excreted by the kidneys, having undergone decomposition, and appearing as urea. It does not contain either sulphur or phosphorus.

The protein bodies are readily detected by Millon's test, which consists of a solution of mercury, formed by dissolving one part of pure quicksilver in two of nitric acid of 1·41

specific gravity. On adding this solution to any fluid suspected to contain a proteinaceous substance, and raising the temperature to from 140° to 212°, a bright-red color is produced. Gelatin causes the same reaction.

Albumen, the most important of the nitrogenous alimentary principles, occurs both in the animal and vegetable kingdoms. It is found in flesh as musculin, in the blood as seralbumen or globulin, in the egg as ovalbumen, and in the vegetable kingdom as emulsin. It is also met with under other names, which it is scarcely necessary to allude to further, as they will be found fully considered in the several treatises on physiological chemistry.*

Albumen is devoid of taste or odor; it is coagulated by a temperature of 145·4° Fahrenheit, forming a white elastic substance insoluble in water. When taken into the stomach, albumen is at once coagulated by the gastric juice, and hence the generally received opinion, that soft-boiled eggs, or those in which the albumen is not coagulated, are more easily digested than those which are hard boiled, is erroneous.

It is a most important article of food, both from the facility with which it is digested and its value as a tissue-forming substance. In a series of investigations† which I instituted upon myself several years since, I showed that the animal temperature could be maintained on a diet consisting only of albumen and water. I found, as the mean of ten days' exclusive use of albumen, that enough was daily absorbed to yield 4216 grains of carbon to the system.

Casein is also a constituent of animal and vegetable substances. It exists in great abundance in milk, from which it may readily be obtained by raising the temperature to

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* The student is referred to Dr. Day's *Chemistry, in its Relations to Physiology and Medicine*, as the best work on the subject adapted to his wants.

† Physiological Memoirs, p. 84.

about 150° Fahrenheit and stirring in a few drops of acetic acid. The mucous membrane of the stomach of the calf or its infusion also possesses the power of separating it. It is likewise separated spontaneously by the fermentation which milk undergoes, and the consequent formation of lactic acid, which coagulates the casein.

The casein of vegetable substances is called *legumin*, and is found in great abundance in peas and beans.

Casein exists in the milk of all animals, in the blood, in the yolk of the egg, (*vitellin*,) and other tissues. It is not coagulated by heat, in which respect it differs from albumen, and is precipitated by lactic and acetic acid from its solutions. When taken into the stomach it is at once coagulated.

Casein is exceedingly nutritious. Coagulated and pressed, to remove the whey, it constitutes cheese, a wholesome article of food, if used before it has become old and undergone those putrefactive changes which, though they add to its flavor, render it indigestible and irritating.

Gluten.—If the dough of wheat flour be washed in a stream of water, the starch, sugar, gum, and soluble matter are removed, and a thick, tenacious, and opaque substance (gluten) remains. It is insoluble in water, but dissolves in acetic acid and in the gastric juice.

Wheat flour contains about 12 per cent. of gluten, to which substance it owes the principal part of its tissue-forming property. It is easy of digestion. Macaroni consists in great part of this substance.

Fibrin is the analogue of gluten in the animal kingdom. It is found in the blood in a state of solution, probably owing to the presence of ammonia, but coagulates, under ordinary circumstances, as soon as the blood is removed from the body. It may be obtained in the form of white shreds by agitating freshly-drawn blood with strips of lead.

THE FATS OR HYDROCARBONS.—The fats are met with

both in the animal and vegetable kingdoms, and both in the liquid and solid form. They differ in composition, but consist of olein, stearin, and margarin in variable proportions. These substances are compounds of oleic, stearic, and margaric acids with glycerin. Certain volatile acids are also present in fats and oils.

The composition of the fats is such that they exert great influence in the production of the animal heat. As we have seen, therefore, they constitute a great portion of the food ingested by the inhabitants of the arctic and antarctic regions. Within the system they undergo oxidation, with the consequent production of carbonic acid and water, a process which is strictly analogous in its effects and its results to the combustion of oil in a lamp or the burning of a candle.

Fat is also essential to the metamorphoses which are constantly going on in the animal body, the nitrogenous aliments being incapable of undergoing solution and digestion in the stomach unless fat is present.

Fat is found in all animals except a few of the lower orders. To man and the higher animals it acts as a non-conductor of heat, and mechanically is useful by serving to protect parts from pressure which would otherwise, from their situation, be liable to injury on this account.

The fats are insoluble in water, but are dissolved to a greater or less extent by alcohol and ether. They are digested by being converted into an emulsion through the action of the pancreatic juice, and thus, being divided into small particles, are capable of being absorbed.

THE AMYLACEOUS AND SACCHARINE PRINCIPLES.—The substances of this class which are used as food are starch, sugar, and gum, of each of which several modified forms exist, but which do not vary essentially from each other. Even the groups themselves present but little difference in composition, all containing twelve atoms of carbon united

to hydrogen and oxygen, which are present in the proportions necessary to form water.

Starch is principally found in the vegetable kingdom, being present in many plants in the form of granules, which are easily recognized, though very variable in form and size. It is obtained by bruising the substance in which it exists and washing with water till the soluble matter and gluten are separated. The starch being insoluble in water is readily collected.

Starch is insoluble in cold water, from the fact that each granule is inclosed in a membranous envelope which resists the action of this menstruum. When hot water is used, the envelope bursts, and the starch, escaping, is dissolved in the water. Chemically, starch is recognized by iodine, which gives a blue or purple color to solutions or mixtures containing it.

Starch is also found in animal tissues under various forms, which, though microscopically presenting different appearances, possess the same chemical reactions, and appear to have the same composition.

The principal use of starch in the economy is as a heat-producing agent. From its easy digestibility, its influence in this respect is very great, and it is even superior to some of the fatty substances which, if we judged solely from their chemical composition, would appear to be more valuable. Boussingault* fed a duck solely upon bacon, and found that enough was not assimilated in a given time to repair the loss through the respiratory process, while another duck, fed upon starch, absorbed nearly twice as much as was sufficient to furnish carbon for the wants of the system. My own experiments† also show that in temperate climates at least, sufficient starch can be assimilated to maintain both the heat and weight of the body.

* Mémoires de Chimie Agricole et de Physiologie, p. 220.

† Physiological Memoirs, p. 112.

Starch, by the action of the saliva, is converted into sugar. The same change is effected by the intestinal juice. It is only under this last-named form that it is absorbed into the blood.

Although starch is found in the animal organism, by far its principal source is the vegetable kingdom. The several grains used as food, with most of the other vegetables, contain it in large quantity, and under the forms of arrow-root, tapioca, sago, tous-les-mois, and many other varieties, it constitutes an important and useful article of food. As neither of these substances can be considered as compound articles of food, it will be proper to consider them in detail in the present chapter.

Arrow-root.—Arrow-root is starch obtained from the tuberous roots of the *Maranta arundinacea.* The roots are washed, and squeezed or beaten into a pulp with water, so as to separate the starch from the fibrous portion. The former remains suspended in the water, from which it is deposited on standing.

The plant from which arrow-root is derived grows in the East and West Indies, in the southern part of Africa, and in Georgia and Florida. That which comes from Bermuda is esteemed as the purest and best.

Arrow-root, as found in the market, consists of a pure, white powder, which, when pressed between the fingers, produces a crackling sound. It is the purest form in which starch is found in commerce. As an article of diet for the sick and for children it is very valuable, on account of its unirritating properties, and when boiled with milk an aliment is obtained which fulfils all the requirements of the system. When it is prepared with water its nutritious qualities are much lessened, as then it is incapable of forming tissue. In certain low conditions, in which it is of more importance to provide for the continuance of the respiratory process and the maintenance of the animal

temperature than the formation of tissue, arrow-root and water constitute a very useful article of diet, and one which is easy of digestion, as the residue to be excreted as feces is almost nothing.

In typhus and typhoid fevers, and in inflammatory affections of the stomach and bowels, arrow-root may be very advantageously employed.

The best way of preparing arrow-root for internal administration is to mix a tablespoonful into a thin paste with cold water and to add gradually a pint of boiling water or milk, stirring the mixture continually during the process. Part milk and part water may be used if considered desirable. In this way a smooth, uniform, gelatinous solution is obtained, which may be sweetened before being ingested. Wine and spices may also at times be added. On cooling, such a solution becomes of a semi-solid consistence, and if a sufficient amount of arrow-root has been used with milk a very palatable *blanc-mange* is formed, which is not only grateful to the taste of the sick, but is also highly nutritious.

From the high price which it ordinarily commands, arrow-root has always been subject to extensive adulteration. To such an extent has this been carried, and so inferior was the article in the market, that at the last revision of the army medical supply table its place was supplied by corn starch, which is an excellent substitute, and altogether free from the irritating qualities of the potato starch, with which arrow-root is generally sophisticated. Corn starch can always be obtained pure, and is much less expensive than arrow-root. While it is not so desirable in every respect as the pure arrow-root, it is far better than the ordinary commercial article with which the market is supplied.

For the detection of the impurities of arrow-root, the microscope affords the most ready and effectual means.

In fact, chemistry gives no tests which are at all reliable. The muriatic acid test is altogether worthless, as I have ascertained by trial.

In order to be able to apply the microscope effectually to the examination of arrow-root, it is of course necessary to be thoroughly acquainted with its microscopical characteristics. Starch granules of all kinds possess certain features in common, but a careful examination of them enables a correct discrimination to be made between them.

A small portion of this or any other form of starch which it may be desirable to examine microscopically is mixed with a little cold water, and a thin layer spread on a glass slide. If too thickly spread, a drop or two of water may be added. It is covered with a piece of thin glass, and is ready for examination.

The starch granules of the maranta arrow-root vary in length from the 2000th to the 800th of an inch, and in width from the 3500th to the 1200th. In form they are irregularly ovoidal, one extremity being generally more rounded than the other, giving them very much the appearance of small oysters. The hilum is situated at one extremity, generally the more pointed one, and is well marked; a dark line extends from it transversely on each side. Sometimes, however, there are radiating lines, and occasionally none at all. No other form of starch granule has such a hilum, and after it is once recognized a distinctive characteristic is obtained. Numerous concentric lines surround it.

The granules of potato starch, with which arrow-root is generally adulterated, are much less uniform in size, ranging from the 4000th to the 250th of an inch in their long diameter, and thus a good indication is obtained, as the granules of arrow-root are never as large and rarely as small as this.

Tapioca is obtained from the root of the *Janipha manihot*,

a poisonous plant growing in Brazil and other parts of tropical South America. It is also found in the West Indies, where it is called the cassava tree. Two other species of the same plant, which are devoid of poisonous properties, also yield tapioca. The root, which is tuberous, is large, and contains a quantity of a milky juice, which owes its white appearance to the starch which it holds in suspension. The root is bruised, and made into a pulp with water. It is then subjected to pressure, by which the juice is made to exude. The powder which is deposited from it is washed, and dried by exposure to artificial heat, by which process the envelope of the starch granule is ruptured. In this form it constitutes the tapioca of commerce, and is met with as irregularly-shaped grains, of a white color, and varying in size from the 24th to the 4th of an inch. The poisonous principle, a portion of which is pressed out with the juice, is entirely dissipated by the heat to which the powder is subjected. The root which remains is also heated, to volatilize the deleterious substance, and is then made into bread or cakes.

Owing to the rupture of the membrane surrounding the starch granule, tapioca is, to some extent, soluble in cold water. It is unirritating to the bowels, and, according to Dr. Christison, is less liable to turn sour, during digestion, than any other form of starch. According to my experience it is no better in this respect than arrow-root or corn starch. It forms a more consistent jelly than the former substance, and presents some peculiarities of taste and appearance which render it a desirable article of food for the sick. It should be well boiled before being ingested. A tablespoonful may be stirred into a pint of warm water and allowed to macerate for half an hour. It is then to be well boiled for ten or fifteen minutes. Milk or water may be used as the solvent, and sugar, spices, and wine added as occasion may require. With eggs and milk a

very nutritious and palatable pudding is made. Tapioca may be substituted for arrow-root in all diseases in which the former is useful.

The adulteration of tapioca is not carried to any very great extent in this country. The microscope readily detects any sophistication, as the granules of this variety of starch are, owing to natural characteristics and the alteration which they have undergone by the heat to which they have been subjected, readily distinguished from those of other kinds of starch. The hilum and concentric lines are obliterated, and the granules are found split into two or more fragments. Pieces of the enveloping membrane are also to be seen. In their natural state the granules are small, being about the 2000th of an inch in diameter, and of a rounded form. The hilum is distinct, and surrounded by concentric rings. As found in commerce, both the natural and altered granules are present, the latter predominating.

Sago is prepared from the pith of several species of *Sagus*, a tree belonging to the order Palmaceæ, inhabiting the East Indies. The stem of the tree is broken into fine pieces and mixed with water. The mixture is strained, by which process the woody fiber is separated. The water containing the starch is then removed by evaporation, and the farina is left behind. This is subsequently rubbed into a paste with water, and moulded into small round grains about the size of the head of a pin, in which state only it is found in the market in this country.

Sago is only slightly soluble in cold water, and requires long-continued boiling to dissolve in hot water. As ordinarily cooked, the grains can be readily distinguished.

The starch granules of sago, as they are seen in sago meal, a preparation which is imported into England, are oblong, rounded at one end, and generally square at the other. The hilum is circular when perfect, but is often

cracked in the form of a star, cross, or slit. The concentric rings are not so distinctly marked as in other varieties. The granules are, in the mean, fully twice the size of those of arrow-root. In the pearl sago the process which it has undergone in the preparation of the grains has destroyed the characteristic features of the granules. The hilum is obliterated, but the concentric lines are still indistinctly visible. The size of the granules is unchanged.

Sago is adulterated with potato starch, the granules of which admit of easy detection with the microscope.

As an article of food for the sick, sago is very excellent, provided it be well cooked; otherwise, the grains not being thoroughly broken up, the starch granules would many of them remain undissolved, and might give rise to intestinal irritation. A tablespoonful to a pint of water or milk makes a mixture less consistent than other forms of starch, and is extremely unirritating. It should boil for fifteen or twenty minutes, being well stirred during the process to prevent scorching and to insure the perfect solution of the granules. It should then be strained, in order to separate any masses not thoroughly dissolved. Spices, sugar, and wine may be added if not contraindicated.

Corn starch is an admirable substitute for arrow-root, is fully as unirritating, and can always, in this country, be obtained pure and in any quantity that may be required. It is prepared from Indian-corn by bruising and washing the grains, and allowing the starch to subside from the water in which it is suspended. Its cheapness prevents its adulteration.

As an article of food it is prepared in the same way as arrow-root, but as it forms a firmer jelly so much of it need not be used. It makes a very excellent *blanc-mange,* and with eggs and milk very good puddings.

Potato starch is not well adapted for use as an article of food, on account of the tendency it possesses to produce

irritation of the stomach and intestines. It is extensively used to adulterate the other more costly kinds of starch. Its microscopical characteristics will sufficiently distinguish it from any other varieties.

Tous-les-mois.—This variety of starch is prepared from the root of a species of Canna, probably the *Canna coccinea*, a plant growing in the West India Islands.

Canna starch is a fine white powder, and can readily be distinguished microscopically from any other form of starch, on account of the large size of its granules. The hilum is round and is situated at the small extremity of the granule. The concentric rings are very close together and more regularly arranged than in other varieties.

Canna forms a thick jelly after being boiled in water and suffered to cool, which is a very advantageous article of diet for the sick or convalescent. It is prepared for food in the same way as arrow-root.

There are other forms of starch to which attention might be directed, but they possess no peculiarities worthy of special mention. Oatmeal, rice flour, barley, etc., though constituted in great part of starch, contain other substances which make them compound articles of food.

Sugar.—Sugar occurs principally under two forms—*cane sugar* and *grape sugar*. Other saccharine principles exist, but as they are not used as food, their consideration need not detain us. In composition both forms are analogous to starch, differing only in the number of hydrogen and oxygen atoms.

Cane sugar is principally obtained from the sugar cane, a plant growing in tropical countries throughout the world, but is also derived from the beet and the sugar maple. Beet sugar is manufactured in large quantity in France and Germany, and maple sugar in the United States and Canada. It is likewise obtained from the Chinese sugar cane, though the greater part of the saccharine principle of this plant is grape sugar.

From all these plants sugar is prepared by evaporating the expressed juice, or, as in the case of the sugar maple, the sap, as it is collected in the spring. The evaporation is carried on until the sugar granulates, when the syrup is drawn off. As thus prepared, sugar is in dark-yellow grains or in compact cakes, according to the degree of concentration which has been reached. White sugar is made by subjecting the impure brown sugar to refining processes.

Grape sugar is uncrystallizable, differing in this respect from cane sugar. It is found in fruits, in the Chinese sugar cane, and is the sugar which is present in the urine in diabetes, and is formed from the action of the digestive juices on starch and cane sugar. It is not so sweet as cane sugar, two parts of the latter being equal in this respect to five of the former.

As an article of diet sugar of either form is rarely if ever used, except as an adjunct to some other food. Its physiological properties cannot be very different from those of starch, owing to the similarity of composition, and, as we have seen, starch is converted into sugar before assimilation.

Sugar is by no means unwholesome, but, on the contrary, is excellent as a respiratory article of food. As is well known, the laborers who extract it from the plants in which it exists eat it in large quantities, and find in it a nutritious and agreeable substance. The negroes of Louisiana, employed on the sugar plantations during the sugar season, eat it in enormous quantities, and grow fat under its use. It is also very fattening to domestic animals.

In disordered conditions of the stomach, sugar should not be ingested, as it is, under such circumstances, apt to undergo fermentation with the consequent production of carbonic acid and alcohol. A solution of pure cane sugar in water does not ferment, the only change which takes place being its conversion, by a slow process, into grape sugar.

Within the system this change does not ordinarily take place, for the reason that the saccharine matter is digested before there is time for it to be initiated; but when there is a torpid condition of the digestive organs, the sugar, or the substances in which it exists, remains in the stomach sufficiently long for the nitrogenous matters present to set up the fermentative action.

Besides converting starch into sugar, the intestinal juice exercises the further action of converting sugar into lactic acid, and it is probable that, if the contact is maintained sufficiently long, the gastric juice will effect the same change. Under its influence cane sugar is certainly transformed into grape sugar, as I have ascertained by experiment. The same fact was determined by MM. Bouchardat and Sandras* several years since, but has been denied by other investigators. That the lactic acid fermentation can also take place in the stomach under certain circumstances, giving rise to heartburn, water-brash, and other symptoms of dyspepsia, is, I think, very certain. MM. Fremy and Boutron† ascertained that solutions of sugar were transformed into lactic acid under the influence of certain putrefying nitrogenous substances, such as cheese and others which enter into the composition of the food. M. Pasteur,‡ who has given very great attention to this and allied subjects, has shown that the change is not due to putrefaction, but to the presence of innumerable and very small infusoria or animalcules. These little beings appear to possess the power of inducing the lactic acid fermentation, just as the yeast-plant or *torula cerevisiæ* causes the alcoholic fermenta-

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* De la Digestion des Matieres feculents et sucrées, etc. Supplement à l'Annuaire de Thérapeutique, 1846, p. 83.

† Recherches sur la Fermentation lactique. Ann. de Chimie, 1841, tome ii. p. 257.

‡ Memoir sur la Fermentation appelée lactique. Ann. de Chimie, 1858, tome lii. p. 404. Also Comptes Rendus, 1860, tome l p. 849.

tion. It is very easy to prove the presence of these organisms. A solution of sugar is mixed with a little cheese and exposed to the atmosphere, at a temperature of from 80° to 90° Fahrenheit. In a few hours, upon examining a drop of it microscopically, myriads of these infusoria will be found to have made their appearance, and lactic acid will have been developed. Gluten and the flesh of animals will cause the same formations, but not with the same rapidity as cheese. It is probably owing to this property of casein, of which a large quantity is ingested by children in milk, that in them the lactic acid fermentation is so readily induced. Sugar is therefore more apt to cause intestinal disturbance in children than in grown persons, though even in these latter, as has been said, if gastric digestion is delayed, the lactic acid fermentation is liable to be established.

Sugar is not of itself capable of supporting life for any considerable length of time. Magendie* found that dogs fed on pure sugar died from defective nutrition. Thus one of these animals was fed exclusively upon pure sugar and water. For the first seven or eight days it appeared to thrive, was lively, and seemed to relish its food. Soon afterward it commenced to lose flesh, though its appetite was still good, and eventually it became very feeble, an ulcer appearing on each cornea, through the perforation caused by which the humors of the eye escaped. On the thirty-second day, the animal, very much emaciated, died. Similar results were obtained by Tiedemann and Gmelin,† and my own unpublished experiments also show that sugar alone is not capable of sustaining life.

But, though this is the case, the beneficial effects of sugar

* Physiologie, tome ii. p. 390; and Ann. de Chimie et de Phys., tome iii. p. 66.

† Recherches Expérimentales Physiologiques et Chimiques sur la Digestions, etc. Paris, 1827, seconde partie, p. 218.

cannot be denied. Its composition shows it to be a good respiratory food, and there is no doubt in regard to its conversion into fat. I have known several persons who became corpulent from no other cause, as far as could be ascertained, than from the ingestion of large quantities of sugar. It cannot, however, of itself produce any of the animal tissues except fat, for the reason that it is devoid of nitrogen; and hence, in animals fed entirely on it, the waste of the muscles and other organs is not supplied. If there was an absorption by the lungs of nitrogen from the atmosphere, this difficulty might be obviated; but, on the contrary, nitrogen is excreted in respiration instead of being taken into the system. The instances of insects feeding entirely on sugar are not valid, as they eat brown inferior sugars, which always contain nitrogenous matters. Insects cannot maintain life on pure white sugar much longer than they can exist on no food at all.

The moderate use of sugar as an article of food is not, therefore, to be condemned; on the contrary, its presence in milk is sufficient to prove its usefulness, and the instinct which children show for it is certainly entitled to be regarded as an indication of its value. For the sick it is generally a grateful addition to those amylaceous and nitrogenous mixtures, such as arrow-root, sago, tapioca, etc., with milk and eggs, which I have never seen do harm, except in certain kinds of dyspepsia. The generally received view, that sugar is productive of decay of the teeth, is altogether without the least proof to sustain it; on the contrary, it is an excellent preservative for all animal tissues. If it comes in contact with the exposed nerve of a tooth, it causes toothache, which fact is doubtless the origin of the above-mentioned idea.

The antiseptic properties of sugar render it of much value as a preservative of certain articles of food, which otherwise could not be kept more than a few days without spoil-

ing. Fruits of various kinds are thus, by being cooked with sugar and surrounded with syrup, preserved for years, and constitute agreeable and nutritious alimentary substances. It is also an excellent adjunct in the preservation of ham and beef, improving the flavor and lessening the tendency to putrefaction.

Sugar is subject to adulteration with starch, chalk, sulphate of lime, and sand. As all of these substances are insoluble in water their detection becomes very easy. The microscope will also reveal their presence. I have met with several samples of powdered white sugar which were adulterated with starch, and one in which a considerable quantity of chalk was present. If this substance is employed as the adulterating agent, the residue insoluble in water will dissolve with effervescence in any strong acid.

Grape sugar, which is extensively manufactured from potato starch, is also used in the adulteration of cane sugar. As it is not half so sweet as the latter, its detection is a matter of importance. This is readily accomplished by means of Trommer's test, which depends upon the fact that the oxide of copper is reduced to the form of the suboxide by grape sugar and not by cane sugar. To a solution of sugar a few drops of a solution of sulphate of copper are added, and then a small quantity of solution of caustic potash. The mixture is now boiled in a test tube. If dextrine be present, the solution becomes of an olive-green color, and if grape sugar, the oxide of copper which has formed is reduced to the orange-colored suboxide, which gives its hue to the whole mixture.

Brown sugar is generally full of impurities, consisting of fragments of sugar cane, gum, a peculiar nitrogenous matter, silica, salts of lime and potash, the spores of the sugar fungus, and a species of acarus or mite. Owing to the presence of these substances, brown sugar should not be used for the sick, and preferably not by healthy persons.

By dissolving brown sugar in water it will be seen that the proportion of insoluble impurities present is quite large. The greater part consists of minute fragments of sugar cane, which are only distinguishable with the microscope. In the sediment the spores of the fungus, consisting of small ovoid bodies, often united so as to form beaded branches, are seen; and it is here that the acari can generally be collected. The *acarus sacchari* belongs to the same genus as the itch insect, and in my examinations of many samples of the coarsest brown sugars I have never failed to find it. Hassall* expresses the opinion that the grocer's itch, a disease of the skin, attended with itching and the formation of little pustules, is caused by this sugar mite, just as the *acarus scabei* produces the true itch. This is, I think, very plausible.

Under the head of sugar it will be proper to mention molasses, a substance which, though not pure sugar, scarcely admits of consideration elsewhere. It consists of the uncrystallizable portion of the juice of the cane, the maple, and the Chinese cane, which is united to gummy and coloring matters, dissolved in water. It is met with in commerce as West India molasses, which is of a black color, has the odor of rum, and is used in the manufacture of this liquor; and as sugar-house molasses, which is thicker and of a different flavor. Refined, and the extraneous matters thus removed, molasses is converted into a golden-yellow syrup, possessing less sweetness than the crude molasses, and on many accounts less desirable as an article of food.

Molasses is issued to the troops of the United States army whenever the medical officers certify to its necessity, and is in regular use in the army hospitals. It is an agreeable and nutritious aliment, and is supposed to possess antiscorbutic virtues. Whether it has any direct power against

* Adulterations Detected, etc. London, 1857, p. 193.

scurvy or not, no doubt can exist relative to its good effects after the men have been subjected for some time to a uniform diet, as may be the case in the field and on the frontier.

Gum.—As an article of food gum is entitled to a very low rank, not so much on account of its composition, as it is very similar in this respect to starch and sugar, but because it is not capable of being so acted upon by the digestive juices as to be brought into a form fit for assimilation. Boussingault* fed a duck with fifty grammes of gum-arabic, and found forty-six in the excrement; and Frerichs, Blondlot, and Lehmann† found that neither the saliva nor the gastric juice exercised any effect upon this substance.

I confined myself for four days to a diet consisting exclusively of gum-arabic and water. During this period I ingested a total of 29,750 grains of gum, of which 27,651 were recovered with the excrement, and it is very probable the whole amount was thus discharged. I lost during the experiments 3·33 pounds, and suffered very much from hunger and intestinal irritation. Hence I considered myself warranted in concluding "that gum is altogether incapable of assimilation, and therefore possesses no calorifacient or nutritive power whatever, but is, on the contrary, a source of irritation to the digestive organs."‡

The administration of gum-water to invalids is, therefore, I think, to be condemned not only as useless but as injurious. The water is soon absorbed, leaving the undigested gum in the alimentary canal to excite disturbance. I have seen several cases of intestinal irritation in children from the eating of gum-drops.

The stories which have been told of individuals living for weeks together on gum alone are not entitled to credit.

* Mémoires de Chimie Agricole et de Physiologie, p. 232.

† Lehmann's Physiological Chemistry, vol. ii. p. 386.

‡ Physiological Memoirs, p. 137 et seq.

INORGANIC ALIMENTS.—Under this head are included those mineral substances which are found as constituents of the compound articles of food, or which are ingested uncombined. They are equally necessary with the organic aliments to the maintenance of life, and contribute directly to the formation of tissues. The bones, the muscles, the viscera, the skin and appendages, and the blood all contain mineral matter; and unless the necessary substances to replenish the waste which is constantly going on are supplied, disease and even death are the results.

Mineral substances will not of themselves support life, although there is evidence to show that some nations or tribes subsist, during certain seasons, wholly or in part on matters which appear to be inorganic. Thus Humboldt* states that the Ottomaks, a tribe of Indians living on the Oronoco, in South America, during the rainy season live entirely on a ferruginous clay, of which each adult eats a pound or more daily. Other nations of South America eat earth, which, according to Ehrenberg, consists of a mixture of talc and mica. In Georgia and Florida there are dirt-eaters, as they are called, who ingest daily, not from necessity but from a bad habit, large quantities of a kind of clay found in those States. And on the Pacific coast several tribes of Indians reside who eat clay as a part of their food. In Sweden, in 1832, on account of the famine, the little flour which the inhabitants possessed was mixed with the bark of trees and a silicious earth and baked into bread.† Retzius found this earth to consist of the remains of nineteen different species of fossil infusoria.

The effect of the earth-eating propensity on those inhabitants of Georgia and Florida who indulge in it is very well marked. They are pale and exsanguined, the muscles

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* Reise in den Äquinoctial Legenden, B. iv. p. 557.

† Poggendorf's Annalen, B. xxix. p. 261.

feebly developed, the skin dry and harsh, the abdomen enormously distended, and the mental faculties on a par with the physical powers. In all these cases in which life has been sustained on clay and similar substances, there can be no doubt in regard to the presence of organic matters.

Without going into the consideration of all the inorganic substances which enter the composition of the animal tissues, and which must be supplied from without, in order that the system may be kept in a normal condition, it will be interesting to notice some of the more important of them in their relations to human health.

Salt.—Salt is not only found in most articles of food as they naturally exist, but instinct prompts its addition to nearly all the substances which are used as aliments by man. Its function in the organism is something more than that of aiding in the formation of tissue, as it is directly useful in facilitating digestion, by its being the source whence the hydrochloric acid of the gastric juice is derived.

The results which follow confinement to a diet entirely free from salt, or at least containing only the proportion which is chemically united to the other constituents of the food, are very striking. Boussingault,* several years since, investigated this subject thoroughly, and his conclusions are not only interesting but extremely important, as showing how necessary a full allowance of salt is to animals.

Six young bulls were taken for the subjects of the experiments. To three of them salt was given with the forage, and from the other three it was entirely withheld for thirteen months. While it was found that no appreciable effect was produced on the development of the animals, it was very definitely ascertained that, so far as their

* Mémoires de Chimie Agricole et de Physiologie, p. 251 et seq.

appearance was concerned, those which had been supplied with salt were in a much better condition than the others. During the first fourteen days no difference was observable, but after the lapse of a month the effects were very distinctly seen. The skin of both lots was soft and sound, but in those which had received salt the hair was smooth and shining; while in the others it was dull and erect. After a year had passed, in the animals which had not been supplied with salt the hair was matted, and in places it had fallen out, giving to the skin an unhealthy appearance; on the contrary, the others were lively, the skin smooth and shining, and the whole aspect indicative of good condition.

No one who has seen much of animals can have failed to notice the avidity with which they lick up salt which may be offered to them; and every practical farmer understands the necessity which exists of supplying them with it at regular intervals.

It is impossible at the present day to observe in man the effects of a deficiency of salt in the food, unless some one should voluntarily subject himself to the experiment of denying himself the use of it. We are told, however, that, several centuries since, certain crimes were punished in Holland by confining the offenders to a diet of bread and water, with an entire deprivation of salt. The criminals were said to have become insane, and finally idiotic, in which condition they died. Whether these stories are true or not, there is enough evidence, regarding the subject from a purely physiological point of view, to show that salt is an essential element of our food, and that man could not exist long in health without it.

Another question connected with the use of salt as an adjunct to the food relates to the results which ensue when it is ingested in large quantity for a long time. As is well known, salt possesses the faculty of preserving animal sub-

stances from putrefaction, and advantage is taken of this property to preserve pork, beef, and other meats in such a form as to admit of their being used as food a long time after they would otherwise have undergone decomposition. The exact nature of the influence which salt exerts over the substances thus preserved is not altogether understood. According to Liebig, it is due to the affinity which salt has for water, whereby it absorbs a great part of the fluid present, and thus removes one of the essential conditions of putrefaction—moisture. This explanation is doubtless correct as far as it goes. We know that fish, ham, and other salt meats will readily undergo putrefaction if they are exposed so that they can freely absorb moisture. But salt also produces another effect which tends to prevent decomposition; it takes away a portion of the albumen of the meat, which is present in a soluble form, a fact to which Liebig has also called attention.

Now, in abstracting from the animal substances submitted to its action a great portion of the fluid they contain, salt, as Moleschott* reminds us, and as is above intimated, removes from flesh a part of its most nutritious elements. Individuals, therefore, subjected to a diet consisting mainly of salt meat, are not properly nourished, and hence the constitutional disturbance which, under such a circumstance, is always manifested, is due, not to the direct action of the salt, but to the absence from the food of matters which are essential to the well-being of the organism. It is sufficient in this place to state that scurvy and other forms of cachexia, which follow the prolonged use of salt meat, are not the direct consequences of the large quantity of salt ingested—the full consideration of the effects of such food falling under another division of the subject.

* Lehre der Narungsmittel. Dritte Auflage. Erlangen, 1858, p. 154.

Phosphate of lime and *carbonate of lime* are among the most important mineral constituents of the food, if not preeminently essential, forming as they do two-thirds of the weight of the osseous tissue, and being found in considerable quantity in other parts of the body. Bones in which the proportion of these salts is reduced much below the normal standard are soft and easily bent. The disease called rachitis or rickets consists in a deficient amount of phosphate and carbonate of lime in the bones, rendering them unable to support the weight of the body.

Of the two salts, phosphate of lime occurs in the bones in much larger proportion than the carbonate, about 57 parts of the first to 8 of the second being present. In the food they occur as normal constituents of most of the alimentary substances. Wheat, rye, corn, barley, oats, and other grains, carrots, potatoes, turnips, etc. contain the phosphate in considerable quantity. It is also found in abundance in animal food. The carbonate of lime is not so generally present in the articles used as food, but most of them contain it in quite an appreciable amount.

During certain states of the system phosphate of lime is required in such a large quantity that enough is not contained in the food to meet the wants of the organism, and hence the bones become soft and pliable, and if fractured do not readily unite. This is the case in pregnancy and during dentition in children. In such conditions phosphate of lime should be mixed with the food, and the best results will generally follow. It is well known that when hens are fed upon food which is deficient in lime their eggs are devoid of shells, and that by feeding them upon substances which contain it in due proportion, or giving them lime-water as a drink, the shells are again formed around the eggs.

Beneke* has called attention to the value of phosphate

* Der phosphorsaure Kalk in physiologischer und therapeutischer. Beziehung, 1851. And, Zur Physiologie und Pathologie des phosphorsauren und oxalsauren Kalkes.

of lime in cell-formation, and its consequent probable benefit in those conditions of the system in which there is defective nutrition, such as scrofula, phthisis, etc. I have treated several cases of scrofulous enlargements of the glands, both of the mesentery and neck, with this substance, and always with very positive advantage.

Guano and the various artificial manures contain phosphate of lime in large quantity, and on this fact mainly depends their value as fertilizers. What is thus given to vegetables is returned to man through the food which he ingests.

Iron.—Though present but in small quantity, iron is found in many of the animal tissues, especially in the blood, where it plays a very important though not thoroughly understood part. In chlorosis and other forms of anemia iron is found in diminished quantity in this fluid, and whether or not the symptoms which attend these affections are due to its deficiency, they are mitigated or altogether removed through its action when administered as a medicine.

Iron exists in most of the articles used as food, both of the animal and vegetable kingdoms.

I have several times verified a statement made I think by Prof. Simpson, of Edinburgh, that manganese is equally effectual with iron in causing an increase of the red corpuscles of the blood in anemia, and by administering it to dogs have always found the amount of iron to be augmented under its influence.

There are several other mineral substances which are necessary articles of food. Among these are *sulphur* and *phosphorus*, which, as has already been mentioned, are constituents of the nitrogenous alimentary substances. The former and its combinations exist in almost all the tissues, and are excreted in the urine in increased amount after excessive muscular action. The latter is found in the brain and in the bones as an essential element of the phosphate

of lime, which constitutes so important a part of their composition.

One of the most essential of the inorganic aliments—*water*—has already engaged our attention, when its hygienic relations as food, with its other connections, were pointed out. It is not necessary, therefore, to refer to it again.

Before proceeding to the consideration of the compound aliments, it will be proper to call attention to the regulations by which we should be governed in regard to the quantity and quality of our food, the periods for eating, and other hygienic circumstances bearing upon the subject.

CHAPTER XXIII.

PHYSIOLOGICAL AND SANITARY RELATIONS OF FOOD.

QUANTITY.—The quantity of food which should be ingested must vary, of course, according to the conditions in which the individual is placed, and is also dependent, to a considerable extent, on the quality of the aliment placed at his disposal. During infancy and childhood more food is proportionably eaten than in adult age, and more is required, in consequence of the development of tissue which is taking place. Compared to the weight of its body an infant at the breast takes daily a larger amount of food than a grown man, and youths about the age of puberty not only relatively, but absolutely more in many instances. It is very rarely the case that children will eat a greater quantity of the ordinary aliments than is requisite for them, and therefore it is indiscreet in parents to put too

great restrictions on them in this respect. It is to be recollected that digestion at such ages is performed rapidly, that the constant activity of mind and body which children manifest produces a great destruction of tissue, and that the growth and development of the body, which are unceasingly going on, require material to be supplied in abundance. Food in them is not only necessary to make up for the losses consequent on the organic processes, but to provide pabulum for the new deposits of tissue which are to be formed. The first condition therefore which modifies the quantity of food is *age*.

In the adult period a large amount of food is also required. The growth of the body is completed, but the mental and physical faculties are now exercised to their fullest extent, and consequently the absolute destruction of tissue is greater at this age than at any other, and an absolutely greater amount of food is generally necessary. The size of the body being increased, also necessitates a larger amount of food for its nourishment.

In old age the quantity of food ingested is at its minimum; not only are the digestive powers weaker, but the wants of the system are less, consequent upon the diminished activity both of mind and body attendant upon advanced years.

Climate.—The amount of food ingested by the inhabitants of warm climates is less than that taken by the residents of cold ones. The East Indian lives on a little rice, while the Greenlander eats several pounds of fat meat daily. Even in temperate climates the seasons exercise an influence not only over the quality but the quantity of food taken into the system. Most persons eat more in winter than in summer. The cause is doubtless to be found in the fact that in cold weather a greater quantity of respiratory food is required, in order to keep up the animal heat, than in hot weather, when the external tempera-

ture more nearly approaches the temperature of the body. When the subject of climate was under consideration, instances were adduced relative to the quantity of food taken by the inhabitants of cold regions. Fatty substances form the principal part of their diet, and if these were not used in immense quantities they would undoubtedly perish with cold. In the torrid zone, however, where the opposite condition as to temperature prevails, fruits and farinacea are almost entirely used, to the exclusion of animal food; and as physical exertion is avoided as far as possible, little purely histogenetic food is required.

Occupation also influences the subject. Individuals whose business requires much bodily exertion, or that they should spend much of their time in the open air, eat more than those of sedentary habits. Intense mental occupation is not consistent with indulgence in the pleasures of the table. Hard students are rarely great eaters. On the contrary, the soldier, the sailor, or the plowman requires a large amount of food, of which a considerable portion must be pre-eminently tissue forming. Muscular exertion, therefore, more than mental exertion, causes destruction of tissue, and consequently a greater demand for food for the supply of the waste.

Sex.—As a rule, men eat more than women, and this mainly on account of the greater degree of activity of their lives. During pregnancy and lactation the appetite of the female is increased, owing to the additional demands made upon her system consequent on the growth of the fœtus, and the supply of nourishment for the infant after birth.

There are therefore several factors to be taken into consideration in determining the quantity of food to be ingested. Many estimates have been made, differing, as is usual in such cases, very much from each other. From my own experience, and from a thorough inspection of the dietaries in use in the hospitals and armies of Europe, I

am clearly of the opinion that no people eat more than the inhabitants of the United States. Taking a healthy adult American as our standard, the quantity of food required to maintain his organism not only in a normal condition, but up to the full measure of physical and mental capability, may be placed at about 40 ounces, of which two-thirds should be vegetable and one-third animal. This is in addition to the water he may drink, which will amount to about 20 fluid ounces, and to 8 or 10 fluid ounces of tea or coffee. When we come to the subject of dietaries and rations we shall resume the consideration of this subject more at length.

If an excessive amount of food be habitually taken, the digestive organs have more work thrown upon them than they can accomplish, and consequently derangement of their functions occurs. Before, however, an advanced stage of dyspepsia is reached, obesity or plethora is developed, and a tendency to disease of the brain, the heart, the liver, or other organs, is established. The regulation of the appetite receives very little attention until warnings in the shape of functional disturbance are given, and then it is often too late.

Mr. Lawrence* relates a very instructive case which bears upon this point.

"A very long time ago I was intimately acquainted with a young physician of spare habit, active mind and body, zealously pursuing his profession and taking much walking exercise. Meeting with deserved success, he found it necessary to leave off walking and to keep a carriage. Having agreeable manners and social habits, he lived much in society, when the mode of living was freer than at present, though he did not commit excess. He soon began to in-

* Lectures on Surgery. Delivered in St. Bartholomew's Hospital. London, 1863, p. 114.

crease in bulk, and was joked by his friends on the subject. It was his custom to celebrate his birthday by a jovial meeting, which was concluded by a bowl of punch after supper. On the last occasion he had been in excellent health, and was perfectly well next morning when he left home in his carriage. Having occasion to draw up the blind, he found the left arm motionless and the leg very stiff; it was an attack of hemiplegia, which obliged him to give up his profession. After surviving for a few years, he sunk under advancing disease of the brain."

But the influence of excessive indulgence in the pleasures of the table does not stop with the digestive system and the establishment of proclivities to disease. Habits of idleness and indolence are set up, which add to the difficulties. The metamorphosis of the tissues does not progress with the normal rate of activity, and hence they become soft and unhealthy, with greatly increased liability to disorganization. Moreover, the products of the decay of the tissues instead of being rapidly excreted are retained in the system, and add to the unhealthy condition. An organism thus circumstanced, although not necessarily diseased, is like a powder mine, which only requires a little spark to cause the explosion. A trifling accident or affection may act as the spark, and produce results which never would have followed had the system been in a normal state.

Deficiency of food is even more productive of disorder. In starvation the tissues of the body are consumed for the production of heat, and, their place not being supplied, rapid loss of weight is the consequence. The various other vital processes all involve decomposition of the substance of organs, and add to the loss which the body undergoes. Chossat* ascertained that the depreciation of

* Recherches Experimentales sur l'Inanition, etc. Paris, 1843, p. 47 et seq.

weight in starvation is greatest during the two or three days which immediately precede death.

Human beings subjected to starvation generally become delirious, from the great debility induced by the want of food. They rarely survive the complete deprivation of food longer than eight or ten days, though instances are on record of life continuing during an abstinence of several weeks. Such cases are always open to the suspicion of deceit.

From insufficient food, if the condition continues for a few weeks, disease is almost invariably induced. Typhus and typhoid fever, scurvy, and anemia are the legitimate consequences. In early childhood the whole development of the individual may be arrested, or particular organs may fail to attain to a full growth. Even the fœtus in utero is affected by the food ingested by the mother, and if there is a deficiency in quality or quantity, the result to the offspring is often such as to interfere with the proper nutrition of its organs, and hence it may be born stunted in growth or with deformed limbs. Pregnant women should always be allowed a full and nutritious diet.

In regard, further, to the quantity of food to be ingested by healthy persons, the appetite may generally be depended on for an indication, if means are not taken, by the use of condiments and luxurious modes of cooking, to stimulate this sensation to an unnatural point. It very rarely occurs that a person eats too much bread or meat, or of a plain dinner of roast beef and vegetables. The danger is from highly-seasoned aliments, and from those which are made more alluring through the skill of the cook. In these cases the judgment should always be exercised and the appetite held in restraint.

Quality of the Food.—As we have seen, there are different kinds of food, each of which fulfils its office in the economy. It is therefore necessary that the food of man

should consist of a variety of substances, in order that the several functions of the organism may be properly carried on. No fact in dietetics is better established than this relative to the absolute necessity of a mixture of aliments. The experiments of Magendie, some years since, afforded conclusive evidence on this point, if it had not already been sufficiently ascertained by the results which were found to follow in man when he was confined to a uniform diet.

Magendie caused different dogs to be fed separately with sugar, gum, olive oil, and butter, with the invariable result that death took place in a little more than a month. I have subjected animals to a uniform diet of nitrogenous substances—albumen, gelatin, and casein—and always found that death took place within three months. Even when the food consisted of two primary aliments, such as bread, which contains gluten, and starch, the health was always deranged, though death did not occur.

All dietaries should be constructed so as to allow of a due admixture of animal and vegetable food, containing substances belonging to all the classes previously mentioned. Even this is not enough; the articles must be varied at times, or disease will be very apt to occur. Thus it will not answer to adhere uniformly to a diet consisting of bread, beef, and potatoes, although such substances are excellent articles of food, and are sufficient to meet every want of the economy. It will be necessary occasionally to substitute some other meat for beef, and some other vegetable for potatoes, and to introduce an extra article at times. If care is not taken to insure variability in the diet of individuals, their sanitary condition always becomes lowered. This is seen in armies, navies, and hospitals, when either through necessity or neglect the food is not sufficiently varied in its character. The strength of the men is not at its maximum: they become low-spirited and

nostalgic; scurvy and fever appear; wounds heal with difficulty, and convalescence is slow.

Although many vegetable substances contain nitrogenous matter, the structure of the teeth and alimentary canal of man shows that nature intended that animal food should contribute to his sustenance. It is doubtless the case that man can live on vegetables alone, and perhaps in some instances flourish on them, particularly in hot climates, where he does not indulge either in strong physical or mental exertion. But in temperate or cold climates, especially if it is necessary to exert his mental or muscular systems to any considerable extent, he soon experiences the want of more invigorating food than can be obtained from the vegetable kingdom alone. On the other hand, in temperate or warm climates a diet exclusively animal is calculated to induce a plethoric condition of the system, unless its effects are counterbalanced by a proportionate amount of bodily exercise being indulged in. It may be safely asserted that the more nutritious the diet—provided it is not made too stimulant by condiments—to which a man is subjected, the more work he is capable of performing, whether this be mental or physical. It is of course to be understood that the quantity taken should be such as will not overtax his digestive organs.

Periods for Eating.—Habit is the principal influence exerted to determine the times for taking nourishment. The importance of regularity in this respect is generally admitted by all. When the meals are taken at stated periods, digestion is always better performed and the system better nourished than when they are eaten at irregular times. The digestive organs are prepared for the reception of the food at the periods they have been accustomed to receive it, and hence they act with greater efficiency than if aliment is ingested without regard to system.

Three meals should be eaten daily—one in the morning,

soon after getting up, another some time after the middle of the day, and a third toward evening. There is no regularity observed by civilized nations relative to the hours for these meals. They are arranged according to the necessities or caprices of the individuals concerned. There are three points, however, to be observed in considering the matter hygienically, and if they are attended to it does not make much difference in regard to the exact hours for breakfasting, dining, and supping.

First, breakfast should be taken immediately after rising in the morning, and before any work is performed. This meal being that after the longest fast, is more important than any other. If any considerable length of time is allowed to elapse before it is eaten, the system is certain to suffer, and especially so if much muscular exertion is made. Soldiers should always be fed before they are sent to drills, parades, or other labor. Not only will the work be done more efficiently, but the health will be better preserved. It has already been shown how important it is to have taken food into the stomach, before being subjected to the influence of the malarious emanations which have been given off during the night.

In the second place, strong bodily exertion should, as far as possible, be avoided after dinner, especially if this is made the principal meal. Digestion is not accomplished as perfectly under such circumstances as if moderate exercise or even rest for an hour is indulged in. With many persons it is impossible to adhere to this rule, but it is not less important for that reason.

And thirdly, the evening meal should not be taken immediately before going to bed. Although rest is favorable to the first stage of digestion, or that which is performed in the stomach, it is not so with the subsequent stages, when the food has reached the intestines. At least two hours should be allowed to intervene between the last meal and

the hour of retiring. Under all circumstances, the evening meal should be the lightest of the three.

MENTAL EMOTION.—The influence of the mind over digestion is very striking, and often of such a character as to interfere materially with the due performance of this function. It is very important with invalids and children, whose nervous systems are easily affected, that nothing should be allowed to excite, distress, or irritate them while digestion is going on. I have several times seen children rendered ill by indiscreet persons annoying or fretting them at meals. Intense anxiety of mind will in most persons derange this process.

In the following chapters relative to food, the compound aliments, as they are presented ready formed for the use of mankind, will engage our attention. These will be considered under three heads.

1st. Those which are derived from the animal kingdom.

2d. Those which are derived from the vegetable kingdom.

3d. The accessory articles of food, which are derived from both kingdoms, but which will be more properly treated of under a distinct head.

The mineral substances used as food are, as we have seen, incorporated with those derived from the animal or vegetable kingdoms of nature.

CHAPTER XXIV.

ANIMAL COMPOUND ALIMENTS.

Animal food, as we ordinarily meet with it, consists of nitrogenous matter in union with certain mineral substances and fat. We have therefore in it all the essential elements for the formation of tissue and the maintenance of the animal heat; and on it, it is perfectly possible for man in any climate to exist and continue in a normal condition. In cold climates the principal part of his sustenance is derived from this source, and, indeed, in polar regions vegetable food is never ingested by the inhabitants.

The first food which is taken by man and other mammals is derived from the animal kingdom, and therefore it will be proper to consider it first.

Milk.—Milk has been regarded as the type of what food ought to be, from the fact that on it alone the young of all mammals are reared. We find in it nitrogenous matters, fat, sugar, mineral substances, members of the four groups into which aliments can be arranged; but it cannot be considered as the representative of all food, for the reason that, however well adapted it may be for the nourishment of the body during infancy, it is not suited to supply the place of all other food for adults; and this, not only on account of any peculiarity of composition or arrangement of the substances of which it is formed, but from the fact that the adult stomach is not well adapted to digest it.

Still we find whole nations who make it the chief article of their diet. The Tartars, the Laplanders, and other wan-

dering tribes subsist to a great degree on milk alone. Doubtless habit influences the matter, as it does most all other of our manners and actions.

We can, without much manipulation, obtain from milk the principal elementary substances of which it is composed. On allowing it to stand for a few hours the cream, which consists mainly of the fatty portion, rises to the top, and can be readily removed. A drop submitted to microscopical examination is seen to consist of innumerable globular bodies possessed of a high refracting power, and answering to all the indications of oil globules. They are suspended in a colorless watery fluid, to which they give the characteristic opacity and white color. These globules, by their fusion, which takes place on strong mechanical agitation, form butter; and the fluid which remains, buttermilk, does not differ essentially in composition from skimmed milk.

By allowing milk to stand for a day or two, or in warm weather for a few hours, it separates into two portions—one a semi-solid, the *curd*, the other a thin, watery liquid, the *whey*. The curd consists almost entirely of *casein*, the nitrogenous substance of milk, and that from which cheese is made. The whey is water containing the sugar and the principal part of the mineral constituents.

The proportion of these substances entering into the composition of milk varies according to the animal from which it is derived. Cow's milk, which may be taken as a standard, I found to possess the following constituents. The cow from which it was taken was grazed in a fine clover meadow, and fed on corn meal every morning.

Water	777·26	......
Solids	222·74	......
Casein	......	78·59
Butter	......	73·80
Sugar	......	49·63
Salts	......	10·72

Human milk contains less butter, sugar, and casein than cow's milk. The milk of a healthy nurse, thirty years of age, who had been delivered six months previously, I found to be constituted as follows:—

Water	887·20	......
Solids	112·80	......
Casein	......	38·27
Butter	......	28·67
Sugar	......	44·30
Salts	......	1·56

The density of cow's milk ranges between 1030 and 1033. Vernois and Becquerel,* as the mean of thirty determinations, place it at 1033·38. As the mean of eighty observations of pure milk, in which there was no opportunity for adulteration, I found it to be 1032·78.

Probably no article of food is so frequently adulterated as milk. Fortunately the substance most generally added to it—water—is not of itself injurious, but most persons who desire to have this liquid mixed with the milk they buy prefer to add it themselves. Other substances, however, are incorporated with milk, either to increase its specific gravity after it has been reduced by water, or to restore to it qualities which too much water has taken from it. Molasses, salt, starch, chalk, and it is said calves' or sheeps' brains, are thus added to milk.

The detection of the substances used in the adulteration of milk is comparatively an easy matter. As we have said, the specific gravity of this fluid ranges between 1028 and 1033. If water be added, the specific gravity is lowered, and we at once have an indication of the extent of the adulteration.

For determining the specific gravity of milk, the specific gravity bottle and balance may be used, or what is more

* Du Lait chez la Femme, etc. Paris, 1853, p. 130. Also Ann. d'Hygiène, 1853, tome l.

convenient, though not so accurate, the ordinary hydrometer, which is graduated for the purpose of being applied to milk. As the results of many experiments, I have found that the following table expresses the specific gravities which will be obtained by the addition of the stated quantities of water to the milk:—

Pure milk	1032
Ten parts of water	1029
Fifteen parts of water	1027
Twenty parts of water	1026
Forty parts of water	1016

The hydrometer, however, is not altogether to be relied on, for the reason that a large proportion of cream might give rise, from its low specific gravity, to an error, by leading to the conclusion that the result obtained was due to the admixture of water. It is therefore advisable to use the lactometer, by which the amount of cream present may be accurately ascertained. This instrument is a graduated test-tube. The milk is placed in it, and the instrument set aside long enough for the whole of the cream to rise to the top. The number of divisions which it covers is then read off. The average percentage of cream as thus obtained is about ten, though it is not uncommon in pure milk to have it as low as seven, and in very rich milk as high as fifteen and even twenty.

If any substances have been added to increase the specific gravity, or to give a thickness to the milk after water has been mixed with it, the microscope readily reveals the presence of such as are insoluble. I have several times detected starch in milk, but never any other adulteration except water, though it would appear that in Europe the substances previously mentioned are sometimes used.

Milk forms a very useful article of diet for the sick, especially when cooked with arrow-root and other forms of starch. In combination with eggs, flour, etc. it makes cus-

tards and puddings, which are always nutritious, and generally digestible, but are too rich for very sick persons. Nothing more useful than milk-punch—made with either brandy or whisky—can be employed in the treatment of the low types of fever so frequently met with in armies. Added to tea or coffee, milk increases the nutritive properties of these beverages and lessens their action on the nervous system.

Butter is generally added to farinaceous food, to which it gives flavor, and renders it more useful to the system by supplying the fatty principle. The digestibility of such aliments is increased by the addition of butter.

Casein has already engaged our attention. As cheese it is an exceedingly nutritious substance, and, if new, is readily digested. Old cheese, however, from the chemical change which it has generally undergone, is apt to prove irritating to the alimentary canal, and is sometimes productive of very serious results. Cheese is not suited for the sick.

Whey, which contains the sugar and the greater part of the salts, also retains a portion of the casein and butter. It is a nutritious and easily digested liquid. In some parts of Germany it is extensively used in the treatment of diseases, but possesses no other properties than those of an alimentary character.

Condensed milk, which is in extensive use in our armies and hospitals, answers, when well prepared, for all the dietetical purposes to which fresh milk can be applied. On some accounts it is even preferable, as it enables us to obtain, in a concentrated form, the principles which exist in milk, and is readily diluted to any degree. It has proved most serviceable on the battle-field as a source of nutriment for the wounded, and is so readily transported as to be always at hand.

EGGS.—Eggs contain nitrogenous, oily, and mineral sub-

stances, and hence are both tissue forming and heat producing. The white of the egg consists of water, albumen, and a considerable proportion of saline matter; the yolk consists of water, albumen, oil which is emulsified by mixture with the albumen, and salts.

Eggs contain a great deal of nutriment in a small bulk, and therefore are useful articles of diet for those invalids in whom it is not advisable to load the stomach with much food. Generally they are of easy degestibility, though much depends in this respect on the way in which they are cooked. Raw eggs are not so readily digested as those in which the albumen has been coagulated by heat, though Beaumont arrived at an opposite conclusion. Eggs which are boiled so as to just coagulate the white without hardening the yolk are most wholesome. I have, however, met with several persons whose stomachs would not tolerate a soft-boiled egg, but who could readily digest several that had been thoroughly hardened throughout by long boiling. Fried, roasted, or scrambled eggs are comparatively difficult of digestion.

The raw yolk of the egg, beaten up with milk, sugar, and brandy or whisky, forms a highly nourishing and stimulant diet in cases of low fever and retarded convalescence.

MEAT.—The substances used by man as food, and which come under this head, consist of the muscular fiber, viscera, and other parts of animals. The several classes, mammals, birds, reptiles, fish, articulates, and mollusks, all contribute to supply him with aliment.

This kind of animal food contains albumen, syntonin or musculin—identical in composition with gluten—fat, and mineral substances. By boiling there is extracted from flesh, but especially from bones, cartilages, and ligaments, a substance to which the name of gelatin has been given, and which was for a long time supposed to be highly nutritious. It is now, however, ascertained that it is not

capable of contributing to any of the requirements of the organism, but is excreted mainly by the kidneys very soon after its absorption into the blood.

Without entering into the consideration of the peculiar properties of all the parts of animals which are used as food, we shall confine our remarks to general observations on the flesh, which is that portion to which the greatest importance is to be attached.

Mammals.—The animals of this class which are used as food are very numerous, and differ very much from each other in the character of their flesh and in the degree of digestibility which it possesses. Beef and mutton are easily digested, while pork is not so readily acted upon by the digestive juices. Veal is more difficult of digestion than beef, but lamb and young pig easier than mutton or pork. It would appear to be uniformly the case that, with the exception of veal, the flesh of young animals is more readily digested than that of the full-grown animal.

As a general rule, the flesh of wild animals is more tender than that of those which are domesticated. This is accounted for by the fact that, owing to the greater amount of muscular exercise which they take, the flesh is more rapidly renewed, and is consequently younger than that of animals which are kept in a condition of comparative rest. Thus the flesh of the buffalo is always more tender, other things being equal, than the flesh of the ox, which it resembles very closely in every respect.

The flesh of female animals is not so tough as that of the male. Castration always increases the tenderness and adds to the flavor.

In order that flesh should be readily acted upon by the gastric and intestinal juices it must be divided into small portions. The chemist, when he wishes to dissolve any substance, pulverizes it, in order that a greater surface may be submitted to the action of the dissolving agent. If this

is not done, the solution always requires a longer time to be effected than when the substance is finely comminuted. The teeth are intended to produce the same effect upon the food as the mortar and pestle of the chemist upon the matters to be triturated, and mastication, if properly performed, very greatly facilitates the digestive process. It is too often the case that individuals do not give sufficient time to this operation, and the food being swallowed in large lumps requires a correspondingly longer time to be converted into chyme. That this neglect is a fruitful cause of dyspepsia, there can be no doubt. The trouble does not, however, stop here, for a great part of such imperfectly masticated food, not being subjected to the action of the juices in the alimentary canal, is excreted unaltered, and consequently its nutritive properties are in a great measure lost to the system.

The animal food allowed to the soldiers of the United States Army is beef or pork. The former is issued fresh or salted; the latter salted as mess-pork, or salted and smoked as bacon. The quantity of beef, salt or fresh, issued per day is one and a quarter pounds; the quantity of pork or bacon is three-quarters of a pound. Why a difference of half a pound should be made between the quantity of beef and pork, I do not know. Certainly the latter is not more nutritive than the former.

The Army Regulations require that fresh beef shall be issued in lieu of salt meat as often as the commanding officer may require it. Ordinarily the men get fresh meat four days in the week, and salt meat the other three.

As has already been said, salt meat is not so nutritious as fresh. According to Liebig,* the brine used in preserving meat "contains the chief constituents of a concentrated soup or infusion of meat, and that therefore, in the

* Researches on the Chemistry of Food. London, 1847, p. 134.

process of salting, the composition of the flesh is changed, and this too in a much greater degree than occurs in boiling. In boiling, the highly nutritious albumen remains in the coagulated state in the mass of flesh, but in salting, the albumen is separated from the flesh; for when the brine of salted meat is heated to boiling, a large quantity of albumen separates as a coagulum. This brine has an acid reaction, and gives, with ammonia, a copious precipitate of the double phosphate of ammonia and magnesia." Lactic acid, kreatin, and kreatinin are also present.

When the subject of salt was under consideration, the effect of this substance on meat was also alluded to. The fact cannot be too strongly insisted upon that salt meat is far less nutritious than fresh. A portion of the most valuable constituents of flesh are abstracted by the brine, and a larger quantity of salt meat should be allowed to make up for the deficiency created. Even if there is no restriction as to quantity, it is very certain that the health of man cannot be long sustained upon a diet of which salt meat forms a considerable proportion.

The *manner of cooking* also affects the digestibility of flesh. Roasting develops the flavor, and likewise renders flesh capable of being easier digested than any other method of cooking. It should be carried just so far as to brown the outside without coagulating the albumen of the juice or hardening the muscular fiber. Broiling is also an excellent way of cooking meat; it is analogous to roasting in its effect on flesh, and like it should not be continued too long. Boiling is generally not so advantageous. Salt meats are, however, better cooked in this way than any other. Care is required in cooking by this method to see that the water is boiling hot when the meat is put into it, in order that the albumen of the outside portion may be thoroughly coagulated, and the escape of the juices thus prevented. If this point is neglected and the meat is put

into cold water, which is then gradually raised to the temperature of the boiling point, the juices escape into the water, in a great measure, before the coagulation of the albumen is effected, and thus the meat is rendered dry and difficult of digestion, and is deprived of a considerable portion of its most nutritious constituents.

Frying is a culinary process which should be altogether discarded as the very worst method of cooking which has ever been devised. The medium, fat or oil, requires a very high temperature to bring it to the boiling point, and hence the meat is rendered exceedingly dry and tough. Moreover, the excessive heat renders the oil or fat empyreumatic, and thus irritating to the digestive organs with which it comes in contact.

In baking, the juices are kept in the meat, but the process is too analogous to frying to be a good one. Stewing is, on the contrary, a very excellent method of cooking meats, especially those which are somewhat tough. The juices which exude being retained, add much to the flavor and the nutritious qualities of the meat.

Soups are made by extracting the juices from meat by boiling. If bones, cartilages, membranes, and tendons are used, a soup is obtained which, though it may appear substantial, is really in a great measure devoid of nutritious qualities. Such soups consist in the main of gelatin, and are altogether incapable of supporting life. The tablets which are sold in this country and Europe as concentrated beef tea or portable soup, are nothing but gelatin conjoined with a very small portion of extract of meat. They are therefore inapplicable for the purposes for which they are sold.

In order to make good soup, lean meat should be taken and cut into pieces the size of half an orange. These should be put into *cold* water, which should be very gradually raised to the boiling point, and should then be

allowed to simmer for two or three hours at least. By this process the juices are thoroughly extracted from the meat and become incorporated with the water. The meat consists of musculin alone, and though palatable and useful when eaten with the soup, does not possess all the qualities as an article of food which it had before being cooked.

On this property of meat to part with its albuminous and saline constituents to water depends the process by which extracts of meat are made. Lean beef, for instance, is cut into small pieces and thoroughly extracted with water the temperature of which is not allowed to rise as high as the coagulating point of albumen, (about 150° Fahrenheit.) The meat is then subjected to pressure, so as to remove all the juice which remains. The two liquids are then mixed and evaporated to a syrupy consistence. A tablespoonful of such an extract will make a pint of rich and nourishing soup, which contains all the nutritious elements of the beef except the musculin.

The importance of extract of beef to armies can scarcely be overestimated. Hundreds of lives have been saved by it on the battle-fields of the present war, and as an article of food for the sick it is exceedingly valuable. It is entirely soluble in cold water, and hence can be used whereever water can be procured. Even without this liquid, it can be administered with advantage. The tablets previously mentioned are not soluble in cold water.

Birds.—Many birds are used as food by man. Their flesh does not differ essentially in composition from that of mammals. It usually contains less water than the latter. The remarks made relative to the flesh of mammals are generally applicable to that of birds.

The flesh of birds is ordinarily easy of digestion, with the exception that the flesh of water birds, from the quantity of oil it contains, which is apt to become rancid, and from the fact that it is tougher, is not so readily digested as that of land birds.

The white meat of birds owes its color to the fact that it is in a state of fatty degeneration. It is more tender than the dark part, but not so juicy or so highly flavored.

In regard to cooking the flesh of birds, the principles enunciated under the last head are applicable.

Reptiles.—Very few reptiles are used as food by mankind. The flesh of many of them is, however, tender and nutritious, not differing materially from the flesh of mammals or birds.

In this country several species of turtle are eaten, and are esteemed great delicacies. They are very nutritious, and by no means indigestible for well persons. Owing to the manner in which they are generally cooked, (with wine and spices,) they are not suitable for the sick. In the tropical parts of America, the iguana, a species of lizard, is eaten. It is said to be very palatable and tender.

Frogs are also very tender and palatable, and are eaten very generally by all who have once taken the first mouthful. The flesh is similar, though much more tender and luscious, to that of the chicken. It is easily digested, and is an advantageous article of food for the sick. Generally the hind legs only are used, but I am enabled to say, from experience, that the rest of the flesh is just as good as that of the posterior extremities.

Fish.—Contrary to what might be supposed from a casual examination, the flesh of fish is very similar in composition to that of the animals just mentioned. It contains somewhat more water, less nitrogenous matters, but more phosphates and other salts. Fish form an excellent kind of food, nutritious, and easily digested. The flesh of fish is generally relished by invalids, and forms an unstimulating diet, which should be more frequently used than it is.

By salting, the flavor of fish flesh is entirely changed, and, as in the case of other meat, it is deprived of much of its nutritious element. It is also rendered hard and much more difficult of digestion.

At certain seasons of the year some fish become poisonous. This is the case with the rock-fish or striped bass, which occasionally produces vomiting, and an eruption on the skin resembling urticaria, after being eaten.

Before eating fish it is very necessary to ascertain that they are fresh, that is, have not been long out of the water. This can be determined by an examination of the gills, which retain their bright-red color only for a few hours after the animal is dead. It is far better, however, in the summer season at least, only to purchase fish that are still alive. They can be readily brought to market in boxes containing sufficient water for them to live in for several hours. Fish flesh very readily undergoes putrefaction. Fish should be either boiled, baked, roasted, or broiled. Small fish are very generally fried, and are palatable enough when so cooked, but they are not nearly so digestible as when the other methods are used.

ARTICULATES.—The animals of this division, in use as food, mainly belong to the Crustacea, though in some parts of the world certain insects are eaten. In the first-named class are included the lobster, the crab, the shrimp, the prawn, and the craw-fish. The flesh of these animals is similar in composition to that of fish, but more difficult of digestion. In some cases violent intestinal irritation is excited by this species of food, and an eruption on the skin resembling urticaria is occasionally produced.

The flesh of the Crustacea readily undergoes putrefaction, and if eaten in that condition may give rise to very alarming symptoms. Great care should therefore be taken to insure its being in good condition before it is allowed to come to the table. When fresh it rarely causes any disorder of the digestive system, if eaten by well persons and in moderation.

Insects are not eaten by civilized nations. Several tribes of Indians in the western regions of the United States eat

a species of grasshopper, which is found there in great abundance. The insects are pounded in a kind of mortar and made into cakes, which are baked. Those who have eaten them assert that they are of pleasant flavor and highly nutritious.

MOLLUSKS.—The animals of this class which are used in this country as aliment are the oyster and the clam. In Europe several kinds of snails and other species of shell-fish are eaten.

Oysters are nutritious, and are generally easily digested, though there are some persons who cannot eat them with impunity. The manner in which they are served materially influences their digestibility. Thus, if eaten raw, they are less liable to disagree than if cooked; and if roasted or stewed, are more wholesome than when fried. Made into soup, a very nourishing liquid is obtained. For this purpose the oyster should be cooked in its own liquor, sufficient water being added to prevent scorching.

Clams are very indigestible for almost all persons, unless chopped very fine and made into soup, and even then frequently cause intestinal disturbance.

In using shell-fish as food, care should be taken to avoid such as are not perfectly fresh. Oysters during hot weather are soft and milky, it being the breeding season with them. At such times they are not fit to be eaten.

CHAPTER XXV.

VEGETABLE COMPOUND ALIMENTS.

If we were to consider all the vegetables which are used as food by man, this treatise would be extended far beyond its prescribed limits. We shall therefore merely refer to those principal vegetable substances which are really types of the others.

Among the most important, if not the chief vegetable aliments, are the cereal grains. In general features these resemble each other. Thus they all contain starch, gluten, sugar, gum, mineral salts, woody matter, and water. They therefore embrace in their composition all the alimentary principles already mentioned, and are better adapted for alimentary purposes than any other compound article of food.

The cereal grains are mainly used as food in the form of bread, a substance which is almost universally employed by all nations, from the most barbarous to the most highly civilized.

Wheat is the most important of these grains, not only on account of the extent to which it is cultivated, but also because it is more available for all the wants of the system, in regard to food, than any other of the grains. It contains from 10 to 15 per cent. of gluten, from 56 to 75 per cent. of starch, and from 4 to 9 per cent. of sugar, besides earthy phosphates. It is perfectly possible, therefore, for man to live a long time on wheaten bread, and with less derangement of his system, than upon any other single article of food.

In the manufacture of wheat flour, the grains are ground

and sifted, so as to separate the bran or husk from the true nutritious part. In this process, as ordinarily conducted, there can be no doubt that a great portion of the gluten, which occupies the outer part of the grain, has also been removed, and is thus lost. It has recently been ascertained that it is perfectly possible to separate the outer lamina of the bran without interfering at all with the gluten cells. Flour made with wheat thus prepared is of course to be preferred to that made from grain from which, with the bran, the testa and a large quantity of the gluten have been abstracted. It is said to contain over 18 per cent. of gluten.

Wheat bread is of two kinds—fermented and unfermented. Fermented bread is made by mixing with the dough, yeast, which is gluten in a state of incipient decomposition. Through the influence of the yeast a part of the starch of the flour is converted into dextrin, and this further into grape sugar. A portion of the sugar thus produced undergoes decomposition into carbonic acid and alcohol, and if the action is allowed to continue sufficiently long, lactic, butyric, acetic, and other organic acids are formed.

But something else is accomplished. Through the production of carbonic acid the dough becomes filled with innumerable bubbles of this gas, and when the loaf is put into the oven and baked, the crust which forms on the outside prevents the escape of the gas. The bubbles expand under the influence of the heat, and the bread in consequence becomes *light*. This is a most important quality in bread, as it enables it to be more rapidly acted upon by the digestive juices. If a piece of such bread is squeezed so as to break up these vesicles, it is always more difficult of digestion than bread which has not been subjected to this action. Thus I caused a dog, in which I had formed a gastric fistula, to eat successively equal weights of vesiculated

and compressed bread. I found that the first was digested in two hours and fifteen minutes, while the latter required three hours and thirty-five minutes to be perfectly digested. It is on account of the facility with which warm bread is compressed in breaking or cutting it, and by the action of the teeth, so that the vesicles become obliterated, that it is so much more indigestible than bread which has been baked a few hours.

The preparation of fermented bread is attended with many difficulties, so much so that good bread is a rarity, and as an article of domestic manufacture is still more seldom met with. This is owing to various causes, sometimes to the bad quality of the flour, at others to the condition of the yeast used, and again to the imperfect kneading or baking. It has therefore been an object to devise a method of bread making which would always, with a fair article of flour, secure good bread.

One process consists in adding carbonate of soda to the flour and hydrochloric acid to the water. When the two are mixed so as to make dough, carbonic acid gas is set free and chloride of sodium remains. The difficulty of this process is that, as the apportionment of the amount of carbonate of soda and hydrochloric acid must ordinarily be left to persons who will not appreciate the necessity of mixing them in determinate quantities, it will often happen that one or the other will be in excess, and thus the bread will be, in a manner, spoiled.

To obviate this liability, yeast-powders are manufactured, and are used extensively throughout the United States. They consist of tartaric acid and carbonate of soda, mixed in the proportions to form tartrate of soda. The only difference between this method and that last described is, that tartrate of soda is formed instead of chloride of sodium. It can scarcely be considered desirable to ingest as large a quantity of tartrate of soda, daily, as would be

contained in the quantity of bread eaten in a similar period, and hence, though bread thus made is light and of apparent good quality, it is not such as should be habitually used.

Aerated bread, as it is called, is made by mixing the flour with water which has been strongly impregnated with carbonic acid, and then baking in the usual way. There are several manufactories of aerated bread on the large scale in this country, and the bread is generally liked by those who use it. It is less apt to become stale than the fermented bread, and is palatable and easily digested.

Another process is that devised by Prof. Horsford, of Harvard University. We have seen that in removing the bran from the wheat a great part of the gluten is also removed. Now in this gluten the principal portion of the phosphatic salts is contained, and through their abstraction the wheat is deprived of a part of its nutritious quality, these salts being essential to the formation of bone and likewise of nervous and other tissues. Professor Horsford proposes not only to supply the phosphates thus removed, but at the same time cause the formation of a sufficient amount of carbonic acid to vesiculate the bread. This is done by the addition to the flour of a dry and highly acid phosphate of lime and bicarbonate of soda, in such proportions as will cause the formation of neutral phosphate of lime and phosphate of soda, with the evolution of carbonic acid gas. The bread formed by this process is made with very little labor, is baked in about half an hour, and is exceedingly palatable. No trouble is necessary in mixing the ingredients, as the prepared flour can readily be obtained from most provision dealers and grocers.

In regard to the comparative healthfulness of fermented and unfermented bread, no definite conclusion has yet been reached. It is probable that no great difference exists between them in this respect when both are well made. The risk of bad bread, however, is decidedly greater with the

fermentative process than with those in which other means are taken to render the bread light. There is nothing to warrant the opinion that the microscopic fungi, developed during the fermentation, are at all injurious to health.

In baking bread, both of the fermented and unfermented kinds, it is very necessary, in order to insure its easy digestion, that it should be thoroughly cooked. Bread which is not well baked is tough and indigestible, and never so light as it should be.

Bread is very frequently adulterated, either for the purpose of making that which is made of dark flour look white and fine, or to give increased weight to it. The substance used for the first-named object is alum, which, when added to the dough, renders the bread made of inferior flour whiter and firmer than it would otherwise be. Alum acts by rendering the albumen less soluble, and by preventing the fermentative process from proceeding too far.

The use of alum in bread is injurious, both because it tends to conceal the bad character of the flour employed, and because it is capable of exercising an injurious effect upon the bread by rendering it indigestible. It is also probable that the continued ingestion of alum is calculated to disorder the healthy action of the digestive system.

The presence of alum in bread may be detected by triturating the suspected sample with distilled water, filtering and adding a solution of chloride of barium to the filtrate. If alum be present, a white precipitate of sulphate of baryta will be thrown down.

I have several times detected alum in bread, but never in any very great quantity.

Sulphate of copper would appear to be used in Europe to give whiteness to bread. This is a dangerous poison, and, though it is employed in small quantity, the effects cannot but be injurious. I have never found it in American bread.

Water, when added to the flour in larger amount than is necessary, and the bread is not sufficiently baked, is an adulterant, inasmuch as it increases the weight of the bread without a corresponding amount of nutriment being supplied. Sulphate of lime, chalk, and bone-dust, among inorganic substances, and potatoes, bean flour, and other flours, among organic matters, are occasionally used to adulterate wheat flour. They are more readily detected by the microscope than by other means.

Flour is often rendered unwholesome by the presence of several forms of fungoid growths.

These consist of ergot, (Oidium abortifaciens,) smut, (Uredo caries and Uredo segetum,) and mildew, (Succinia graminis.) Of these ergot is most pernicious, very serious diseases being produced by eating bread made of wheat affected with it. It appears to exert a special effect upon the organic muscular fiber of the capillaries, constringing them, and thereby preventing the circulation of the blood through the whole body. Mortification results in consequence. The other species mentioned are not known to produce any poisonous effects.

Animal organisms are also met with in wheat and wheat flour. A species of vibrio (Vibrio tritici) infests the grain, and a species of acarus (Acarus farinæ) is found in damaged flour. I have never seen the species of this latter genus mentioned and figured by Hassall.*

Indian-corn.—This grain is more extensively used in the United States than in any other part of the world. It contains a greater amount of starch and less nitrogenous matter than wheat, but, in addition, includes among its components a considerable quantity (about 8 per cent.) of a fatty oil.

Bread made of corn meal, though not so digestible as that made of wheat flour, is nutritious, and not liable to disagree

* Adulterations Detected, etc. London, 1857, pp. 268 and 270.

with the digestive organs. Owing to the large amount of oil which exists in it, it is very fattening. Fermented bread is not made with corn meal. The flour is simply mixed with water and salt and baked. Eggs are sometimes added.

Rye, *buckwheat*, *oats*, *barley*, and *rice* are other cereals which are used as food, either as bread or in other forms. The latter is the most easily digested, and is exceedingly useful as an article of diet for the sick. It constitutes a part of the ration issued to the United States troops. Oats are very nutritious, ranking next after wheat in this respect, but the flour made from them is generally considered as somewhat indigestible. Oatmeal is an important article of food in Scotland and other parts of Great Britain, but is not eaten by the inhabitants of the United States, probably on account of the great abundance of other more palatable food.

In regard, further, to the cereal grains, it would be interesting to go more at length into their consideration, but for the reason stated this must be deferred. The remarks which have been made relative to wheat and bread are generally applicable to them and to the bread made from their flour.

Peas and *beans* belong to the leguminous seeds, and contain both nitrogenous and starchy matter. The former is casein, not differing in composition from the casein of milk. They are not very nutritious, and are apt to cause indigestion. They should not therefore be allowed to the sick. In these seeds we have an instance of aliment containing a large proportion of nitrogen and yet which does not possess a high value as nutriment. As Liebig asserts, this is probably owing to the deficient amount of phosphates which they contain. Beans are a part of the army ration. They are generally used to make soup with, and if well cooked are ordinarily of easy digestion in this form.

Among the roots and tubers used as food, the principal are the *potato*, the *turnip*, the *beet*, the *carrot*, and *parsnep*.

The *potato* contains a large proportion of starch, and is an excellent article of food as an adjunct to other substances. It is not, however, to be used as an exclusive aliment, and cannot be so employed without depravation of the blood being the consequence if the attempt is long persevered in.

Potatoes are an excellent antiscorbutic, especially when eaten raw. They are issued to the army as a component part of the ration.

Beets are wholesome and palatable. Though they contain no starch, they possess a substitute in sugar.

Turnips, *carrots*, and *parsneps* are not very digestible, and to many persons, on account of the volatile oil they contain, not very palatable.

There are many other vegetable substances used as food by man, but which cannot now receive notice. Leaving the further consideration of them, we come in the next place to the accessory articles of food, which, in a hygienic point of view, are extremely interesting, but which have not, until late years, received that attention from physiologists and hygieists which their importance demands.

CHAPTER XXVI.

ACCESSORY FOOD.

UNDER the head of accessory food, (a term first, I believe, used by Dr. T. K. Chambers,) I propose to treat of that very important class of substances which, though of doubtful or low status as aliments, are yet extremely useful, either as making the food more savory, as promoters of digestion, or as agents for developing nervous or physical force. The principal articles to be considered in these connections are certain condiments—pepper, cayenne, mustard, and vinegar, alcohol in its various forms, tea and coffee. Tobacco, though not ingested into the stomach, is properly embraced under this head, and will therefore be brought under notice.

CONDIMENTS.—Condiments are those substances which give piquancy or flavor to the food. Another effect which they possess is that of stimulating the action of the salivary glands and stomach by reason of their irritating qualities.

The use of condiments is not altogether to be commended, although there is no doubt that when used with discretion they are capable of being advantageous, especially in promoting the digestion of substances which would otherwise be slowly acted upon by the digestive organs. But it must be recollected that the continual use of irritants is always productive of debility in the tissue to which they are applied. In the case of condiments, when employed in moderation, the disturbance produced is scarcely appreciable, and is more than counterbalanced by the good effects which follow; but if used in excess, not only irrita-

tion and inflammation of the organs with which they immediately come in contact are excited, but other organs are injuriously affected.

It is very easy to demonstrate the action of condiments in increasing the amount of saliva and gastric juice secreted. In regard to the first, it is a matter of common experience that those substances capable of affecting powerfully the nerves of taste cause an augmentation of the quantity of saliva, and the same fact is readily proved by experiments on the lower animals, as for instance the dog, as has been done by Bernard and others. It is, however, a more remarkable fact, and one which shows the intimate sympathetic relation existing between the several functions concerned in digestion, that whatever increases the amount of saliva secreted, likewise increases the quantity of gastric juice. This can be readily shown by putting any strongly sapid substance, as for instance vinegar, in the mouth of a dog in which a gastric fistula has been formed. In a few seconds the gastric juice will run from the fistulous opening, although no portion of the vinegar can have entered the stomach.

This, then, constitutes the chief advantage attendant on the use of condiments, and it is one which entitles them to rank high in the scale as accessory articles of food.

Pepper.—This substance is the unripe fruit of the *Piper nigrum*, a vine growing in the East Indies. Its appearance is familiar to every one, and need not therefore be particularly described. The odor of the berries is somewhat aromatic, and the taste sharp, hot, and acrid. If pepper is taken in large quantity into the stomach it affects the general circulation, causing increased action of the heart and blood-vessels. Pepper is a wholesome stimulant to digestion, and has recently been very properly added to the ration of the American soldier.

Pepper contains an active principle—*piperin*—an essen-

tial oil, and an acrid resin. The former has had some repute as an antiperiodic, but its powers in this respect are scarcely worthy of consideration.

The extent to which pepper is used as a condiment causes it to be frequently adulterated. The microscope affords the most ready means for detecting its sophistication. According to Hassall,* linseed meal, mustard husk, wheat flour, pea flour, sago, rice flour, pepper dust, and woody fiber are used as adulterants of powdered pepper. I have examined a good many samples, but have never detected any foreign matter but linseed and starch.

Cayenne.—Cayenne pepper is prepared from several species of capsicum, of which the *C. annuum* is the principal. This latter, though a native of the tropical regions of Asia and America, is cultivated throughout the greater part of the world. The fruit, which is a small berry, is the part used. It is, when ripe, of a bright-red color.

Cayenne pepper, which is the powder of the several species of capsicum, is not only a condiment, but is a powerful stimulant, much more so than black pepper. It is a very useful addition to food when not too liberally used, and it should always be employed with those substances which are liable to produce flatulence.

Capsicum owes its peculiar properties to the presence of an active principle, *capsicin*, which is an acrid oleo-resin.

The adulterations of cayenne pepper are very numerous. Hassall† states that of twenty-eight samples he examined, twenty-four were sophisticated—red-lead, Venetian red, vermilion, and rice being the principal substances used for this purpose. According to Normandy,‡ brick-dust is frequently used as a sophistication. I have very seldom

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* Op. cit., p. 364. † Op. cit., p. 372.

‡ Commercial Hand-Book of Chemical Analysis. London, 1850, p. 155.

found the cayenne pepper purchased in this country to be adulterated. Once I found a sample to contain starch, and once red ochre.

Mustard is very commonly used in the United States as a condiment. The flour, in which form it is employed, is produced from the seeds of the *Sinapis nigra* and *Sinapis alba*, the former usually predominating. The black mustard is extensively cultivated in the United States, especially in Kentucky. So far as my experience goes, the native article is very seldom adulterated.

For table use, mustard flour is generally mixed into a paste with water, to which a little vinegar and salt are added. It is not ordinarily used with vegetable food, except those substances which are eaten as salads. It is an excellent condiment, and at the same time is gently stimulant to the general system. It contains a volatile oil, to which its peculiar properties are mainly due, but this is only found in the black mustard seed, the white containing a more volatile oil, which, however, does not pre-exist in it, but which is readily formed under certain circumstances.

Hassall found that forty-two samples of mustard purchased in London, and submitted by him to examination, were adulterated with wheat flour and turmeric. I have examined a number of specimens of foreign ground mustard, and have found them all adulterated with wheat flour, and many of them with turmeric in addition. The black Kentucky mustard I have never found adulterated, but one sample ground in New York I found to contain chalk and turmeric, and another gypsum.

Vinegar is a dilute solution of acetic acid in water, prepared by the fermentation of infusion of malt, cider, or wine. In addition to acetic acid, which is the essential constituent, vinegar contains coloring matter, gluten, sugar, malic acid, tartaric acid, and alcohol.

Vinegar is extensively used not only as an addition to

certain kinds of food, but also as a preservative of various vegetable substances, which, when thus prepared, are called *pickles*. It forms a part of the ration of the American soldier. It has been reported to possess antiscorbutic properties, but it is entitled to no such reputation. As a promoter of digestion its virtues are worthy of notice, and it constitutes an agreeable addition to certain articles of food.

Vinegar is adulterated to a considerable extent with sulphuric acid, many samples consisting of nothing but water and this acid, the mixture being colored with burnt sugar. I have met with liquids which were sold for vinegar which did not contain a particle of acetic acid. For the detection of sulphuric acid in vinegar, a solution of chloride of barium or nitrate of barytes is added to the suspected liquid. If sulphuric acid be present, a white precipitate will be thrown down. If the test liquor is added in excess, the whole of the sulphuric acid will be separated, and may be quantitatively determined by weighing the sulphate of baryta produced.

Sulphuric acid is also readily detected by the process described by M. Menge.* A small quantity of solution of sugar in water is placed in a porcelain capsule or saucer and a small portion of the suspected vinegar added. Heat is now applied, and so managed as not to cause the formation of caramel through its agency. If the sugar becomes carbonized toward the end of the process, the existence of sulphuric acid in it is certain.

ALCOHOL AND ITS COMPOUNDS.—The propriety of the use of alcohol, as a beverage, has been a subject of discussion for many years past; but few who have participated in it have considered the matter in its true light. The chief reason why the advocates of a total prohibition of the em-

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* Histoire des Falsifications des Substances Alimentaires et Médicamentaires, etc., par Hureaux. Paris, 1855, p. 636.

ployment of alcoholic liquors have been unable to carry conviction to those to whom they have addressed themselves, is that their remarks have mainly consisted of invectives, and that whatever facts they have brought forward have been altogether based upon the immoderate use of the agents in question. No one can for a moment deny that alcoholic liquors, when used in excessive amount, are not only injurious to the individual, but are also in the highest degree pernicious to society. That is not a subject for discussion, for there is but one conclusion to be arrived at. We can even go farther, and admit that there are certain alcoholic beverages — such as the distilled liquors, whisky, brandy, rum, etc.—which, when taken habitually, though in moderation, by healthy persons, exert a more or less injurious effect, varying according to the quantity imbibed and the constitution and temperament of the individual. It is also undoubtedly true that even fermented liquors—wine, porter, ale, etc.—when used in excess, lead to results in many cases which are decidedly abnormal in their character.

But are such facts to influence us against the proper use of all beverages which contain alcohol? Do we refuse to use cayenne pepper and mustard, because they contain essential oils, which are far more deleterious than alcohol, a few drops sufficing to cause death? Do we banish onions from the list of aliments, because a highly poisonous volatile oil can be obtained from them? Do we reject mutton, because some one has killed himself by eating too heartily of mutton-chops? Now these are the conclusions to which we must come if the use of alcoholic liquors is to be entirely prohibited because, when taken in excess, they lead to disease and death. Their absurdity is so palpable that it is scarcely worth while to discuss the matter further; but as I think it is of the utmost importance that proper views should prevail relative to this subject, I shall point out

briefly some of the fallacies which have been brought forward in regard to it, and also the principal hygienic advantages to be derived from the proper employment of the liquids containing alcohol.

The experiments of Dr. Percy* have been often brought forward as proving something in regard to alcohol which was not true of any other substance. This observer injected strong alcohol into the stomachs of dogs. The quantity varied from two to six ounces. Death followed, and upon examining the blood and brain for alcohol it was always found. The presence of alcohol in the blood and brain, to those who look superficially or ignorantly at the matter, has rather a horrible aspect; but when we know that there is no substance capable of being absorbed by the stomach and intestines which cannot also by proper means be detected in the blood and viscera, the subject loses much of its striking character. Dr. Percy used alcohol of 850° specific gravity, which represents a mixture containing about 80 per cent. of absolute alcohol. As the strongest brandy and whisky contain but about 54 per cent. of alcohol, the concentrated character of the liquor used by Dr. Percy is at once seen. In one case six ounces were passed into the stomach of a dog, a quantity amply sufficient to cause death in an adult man.

The amount of essential oil present in onions is extremely small, far less in proportion than the quantity of alcohol contained in the mildest wines; and yet we cannot eat an onion without this oil passing into the blood, and impregnating the air expired in respiration with its peculiar odor.

Other physiologists have detected alcohol in the blood and viscera after its ingestion into the stomach. MM. Bouchardat and Sandras† recognized alcohol by the odor

* An Experimental Inquiry Concerning the Presence of Alcohol in the Ventricles of the Brain, etc. London, 1839.

† Annales de Chimie et de Physique, 1847, tome xxi. p. 448.

in the blood of dogs which they had caused to swallow it, and in the blood of a man in a state of intoxication. MM. Lallemand, Perrin, and Duroy,* in a series of excellent researches, demonstrated its presence in various tissues of the body; but, ignorant of Percy's investigations, appear to think that they were the first to isolate it.†

I have several times performed experiments with reference to this point, and have never failed to recognize the presence of alcohol in the blood, brain, the stomach, the expired air, and the urine of dogs to which I had administered strong alcohol; but when using liquids containing from 8 to 15 per cent. of alcohol, such as the German, French, and Spanish wines, I have never been able to find it in the solids, though detecting it in the products of respiration, by the solution of bichromate of potassa in sulphuric acid, as employed by MM. Lallemand, Perrin, and Duroy, a test which they lead us to infer is of their own discovery, but which was suggested and used by Masing‡ in 1854.

We see, then, that alcohol, like other substances, is absorbed into the blood, and exerts its influence on the system through the medium of that fluid. In the next place, we have to inquire relative to the effects which it thus produces.

Pure alcohol is a violent poison. In the dose of less than one ounce I have seen it cause death in a medium-sized dog, and many cases are on record of fatal effects being immediately produced in the human subject after comparatively small quantities had been swallowed. When diluted, its effects are not so rapidly manifested, and in this form, when taken in sufficient quantity, the condition known as intoxi-

* Du Rôle de l'Alcool et des Anesthésiques dans l'Organism. Paris, 1860.

† Op. cit., p. 8.

‡ De mutationibus spiritûs vini in corpus ingesti.

cation is produced. Previous to this point being reached, the nervous and circulatory systems become excited, the mental faculties are more active, the heart beats fuller and more rapidly, the face becomes flushed, and the senses are rendered more acute in their perceptions. If now the further ingestion be stopped, the organism soon returns to its former condition without any feeling of depression being experienced; but if the potations are continued, the complete command of the faculties is lost and a condition of temporary insanity is induced. If further quantities are imbibed, a state of prostration follows, marked by coma and complete abolition of the power of sensation and motion. Such is a brief outline of the obvious symptoms which ensue upon the use of alcoholic liquors in considerable quantities. When taken in amounts less than are sufficient to induce any marked effect upon the circulatory and nervous systems, there is, nevertheless, an influence which is felt by the individual, and which is mildly excitatory of the moral and intellectual faculties.

But besides these perceptible results of the use of alcoholic liquors, there are other physiological effects which flow from their use, far surpassing in importance any that have been named, and which mainly render the substances in question useful as aliments.

We have already passed in review the principal phenomena connected with the retrograde metamorphosis of the tissues of the body. We know that a certain amount of tissue is decomposed with every functional action of the organ to which it belongs, and we at once perceive that, were it not for the formative processes which are going on, whereby new material derived from the food is deposited, to take the place of that which is removed, death would very soon result. It is often important to arrest this destruction of tissue, without at the same time lessening the force which would otherwise be derived from its continu-

ance; or it may be desirable to obtain a great amount of force from an individual in a limited period. In alcohol we have an agent which, when judiciously used, enables us to accomplish both these ends, together with others scarcely less important, which will be alluded to more at length hereafter. The operation of alcohol will be best illustrated by an example.

Let us suppose that a plowman, laboring twelve hours a day, upon a diet consisting of ten ounces of meat and sixteen of bread, finds that he loses weight at the rate of one ounce per day. Now, in order to preserve his life, he must either take more food or he must lessen the waste of his tissues. Meat and bread are both expensive, and he finds it difficult to obtain them, or, what is not at all improbable, the quantity which he eats is as much as he has any appetite for. The alternative which presents itself to him is that of working less. If he is his own master, this would be a very excellent way of getting rid of the difficulty. He would shorten the period of his labor to ten hours, and then, instead of losing weight, he would perhaps gain an ounce a day. But it may happen that this alternative is not open to him—he must work twelve hours a day. In this condition of affairs he takes a mug of porter or a glass of wine, or what would be worse, a dram of whisky, after his mid-day meal. He finds that he is pleasantly exhilarated, his vigor is increased, and he labors on to the close of his task contentedly, and when it is concluded, is in better spirits and less fatigued than he has been before when his day's work was ended. He returns to his home, and, on weighing himself, finds that he has lost but half an ounce. He repeats his beverage the next day; like results follow, and, when he weighs himself, he ascertains that he has lost nothing. The inference therefore is, that the beverage he has imbibed, or some constituent of it, has retarded the destruction of his tissues, and has itself aided in sup-

plying the material for the development of the force he has exercised in his labor.

Now it may be supposed that this is altogether a fancy picture, that it is a theory based upon assumptions only, like too many others which encumber science. In physiology or hygiene we believe nothing but that which is demonstrated, and even then we do so provisionally, with the full understanding in our minds that if to-morrow new facts are brought forward which appear to be inconsistent with those upon which a favorite theory rests, and which are of greater weight, the hypothesis shall be abandoned without hesitation. Let us see, therefore, what evidence we have to support the view that alcohol retards the destruction of the tissues and supplies material for the generation of force.

Many years ago, Dr. Prout ascertained that after the use of alcohol the amount of carbonic acid ordinarily excreted by the lungs became considerably reduced. Within the past few years other investigators have arrived at similar conclusions, and have extended their inquiries to the other excretions of the system. Thus Böcker* ascertained that under the use of alcohol not only was the amount of carbonic acid exhaled by the lungs lessened, but there was a very decided diminution in the quantity of urine eliminated and in the amount of its solid constituents.

My own experiments† tend to the same general conclusions as those of Böcker. They had reference to the influence of alcohol when the food was just sufficient for the wants of the organism, when it was not sufficient, and when it was more than sufficient. Four drachms of alcohol were taken at each meal, diluted with an equal quantity of water.

During the first series, when the food was of such a char-

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* Beiträge zur Heilkunde. Crefeld, 1849.

† Physiological Memoirs, p. 43 et seq.

acter and quantity as to maintain the weight of the body at its normal standard, I found, as the result of experiments continued through five days, during which time 60 drachms of alcohol had been taken, that the weight of my body had increased from 226·40 pounds to 226·85 pounds, a difference of ·45 of a pound. In the same period, the amount of carbonic acid and aqueous vapor exhaled from the lungs had undergone diminution, as had likewise the quantity of urea and its solid constituents.

During these experiments my general health was somewhat disturbed. My pulse was increased to an average of ninety per minute, and was fuller and stronger than usual, and there was an indisposition to exertion of any kind. There were also headache and increased heat of skin.

The inference to be drawn from these experiments certainly is that, when the system is supplied with an abundance of food, and when there are no special circumstances existing which render the use of alcohol advisable, its employment as an article of food is not to be commended. But there are two facts which cannot be set aside, and these are, that the body gained in weight and that the excretions were diminished. These phenomena were doubtless owing to the following causes: First, the retardation of the decay of the tissues; second, the diminution in the consumption of the fat of the body; and third, the increase in the assimilative powers of the system, by which the food was more completely appropriated and applied to the formation of tissue.

The *quasi* morbid results which followed are just such as would have ensued upon the use of an excessive amount of food of any kind, or the omission of physical exercise when the body has become habituated to its use. If I had increased the extent of exercise taken, there is no doubt there would not have been the undue excitement of the circulatory and nervous systems that was manifested.

The truth of these propositions is seen in the second series of investigations, during which the food ingested was such as I had previously ascertained involved an average decrease in the weight of the body of ·28 of a pound daily. Under the use of the alcohol, not only was this loss overcome, but there was an average increase of ·03 of a pound daily. The effects upon the excretions were similar to those which ensued in the course of the experiments of the first series.

But, unlike the first series, no abnormal results were produced in the general working of the organism. Digestion was well performed, the mind was clear and active, and there was no excitement of the circulatory or nervous systems; in fact, all the functions of the body appeared to act with energy and efficiency. It is in these cases, therefore, that the proper use of alcohol is to be commended, that is, when the quantity of food is not such as to admit of the due performance of such physical or mental labor as may be necessary, or, what amounts to the same thing, when the digestive or assimilative functions are not so efficiently performed as to cause the digestion and appropriation of a sufficient quantity of the food ingested to meet the requirements of the system.

In the third set of experiments, in which more food was ingested than was necessary, the ill effects of the alcohol were well marked. Headache was constantly present, the sleep was disturbed, the pulse was increased in frequency and force, and there was a general feeling of *malaise*. I am sure that, had the experiments been continued, I should have been made seriously ill. Notwithstanding all these abnormal phenomena, the body continued to increase in weight above the ratio which existed before the alcohol was ingested, and the excretions were diminished in quantity.

After such results, are we not justified in regarding alco-

hol as food? If it is not food, what is it? We have seen that it takes the place of food, and that the weight of the body increases under its use. Any substance which produces the effects which we have seen to attend on the use of alcohol, even though it is not demonstrable at present that it undergoes conversion into tissue, is food. If alcohol is not entitled to this rank, many other substances which are now universally placed in the category of aliments must be degraded from their positions.

But, in addition to the experiments cited, we have the opinions of several eminent physiologists, based upon observation, to bring forward to the same effect. Thus Liebig* affirms that "Alcohol stands high as a respiratory material. Its use enables us to dispense with that of starch and sugar in our food, and is irreconcilable with that of fat.

"In many places destitution and misery have been ascribed to the increasing use of spirits. This is an error.

"The use of spirits is not the cause, but an effect of poverty. It is an exception to the rule when a well-fed man becomes a spirit-drinker. On the other hand, when the laborer earns by his work less than is required to provide the amount of food which is indispensable, in order to restore fully his working power, an unyielding, inexorable law or necessity compels him to have recourse to spirits. He must work, but in consequence of insufficient food, a certain portion of his working power is daily wanting. Spirits, by their action on the nerves, enable him to make up the deficient power *at the expense of his body*, to consume to-day that quantity which ought naturally to have been employed a day later. He draws, so to speak, a bill on his health, which must be always renewed, because, for want of means, he cannot take it up; he consumes his capital

* Familiar Letters on Chemistry, etc., p. 454.

instead of his interest, and the result is the inevitable bankruptcy of his body."

It must be recollected that when these remarks were originally made, the experiments, which show that alcohol does not accelerate the destruction of the tissues, had not been instituted. The observations, therefore, in regard to the spirit-drinker living at the expense of his own body, are not based upon our present knowledge.

Moleschott,* who belongs to a more modern school, takes the other extreme, when he says:—

"He who has little must give little, if he desires to retain as much as one who unites wealth with prodigality. Alcohol is a savings bank for the tissues—if the expression will be understood. He who eats little and drinks moderately of alcohol, retains as much in his blood and tissues as he who, in corresponding relations, eats more and drinks neither beer, nor wine, nor brandy."

Perhaps this view is somewhat extreme, but that it is based upon the truth, there can be little doubt. Alcohol retards the destruction of tissue. By this destruction force is generated, muscles contract, thoughts are developed, organs secrete and excrete. Food supplies the material for new tissue. Now, as alcohol stops the full tide of this decay, it is very plain that it must furnish the force which is developed after it is ingested. How it does this, is not clear. That it enters the blood and permeates all the tissues, is satisfactorily proven. Lallemand, Perrin, and Duroy† contend that it is excreted from the system unaltered. If this were true of *all* the alcohol ingested, its action would be limited to its effects upon the nervous system, produced by actual contact with the nervous tissues;

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* Lehre der Narungsmittel. Für das Volk. Dritte Auflage, 1858, p. 148.

† Op. cit., p. 108 et seq.

but there is no more reason to suppose that *all* the alcohol ingested is thus excreted, unaltered, from the body, than there is for supposing that all the carbon taken as food is excreted by the skin and lungs as carbonic acid.

It is not at all improbable that alcohol itself furnishes the force directly, by entering into combination with the products of tissue decay, whereby they are again formed into tissue, without being excreted as urea, uric acid, etc. These bodies are highly nitrogenous, and, under certain circumstances, might yield their nitrogen to the construction of new tissues. Upon this hypothesis, and upon this alone, so far as I can perceive, can be reconciled the facts that an increase of force and a diminution of the products of the decay of tissue attend upon the ingestion of alcohol.

Another beneficial effect produced by this agent and its combinations is that which it exerts upon the nervous system. Not even physical labor so exhausts the energies of the body as the depressing emotions of the mind. Under their enervating influence the tissues wear away, and the body becomes enfeebled to a degree to which mere muscular exercise could never reduce it. In such cases, alcohol, above every other agent, lessens "the wear and tear" of the mind, increases the assimilative process, and arrests the regressive metamorphosis of tissue, which is reducing the strength and weakening all the functional operations of the organism. Hence the instinctive avidity with which those who are overburdened with care seek to drown their sorrows in the cup. Would it not be wiser in us to yield to the necessity, to recognize the promptings of nature, and, instead of vainly endeavoring to cut off the only source of consolation which many possess, try, while pointing out the true use of alcohol, to show the danger which lurks behind the blessing?

After severe bodily and mental exertion, the system requires time to recuperate, and if the strain has been very

severe, there may be no reaction, and death occurs. As a restorative agent, alcohol has no superior. It quiets the mind, and, by its action on the functions concerned in tissue metamorphosis, enables the organism to regain its former condition with more safety and rapidity than if its use is dispensed with.

No circumstance so thoroughly demonstrates the universality of the instinct which prevails for alcoholic beverages as the fact that all nations which possess the materials fabricate something of the kind. From the Tartar with his koumiss, and the Mexican with his pulque, to the highly civilized nations with the refined wines of the grape, we have the extremes within which there are numerous gradations. It is difficult to resist the force of this fact. It shows how powerful is the craving for alcohol, and it shows how futile must be the attempt to abolish its use.

I have deemed it proper thus to point out at length the real hygienic and physiological advantages attendant upon the use of alcoholic liquors. This use, like that of every other good thing which we have, must be guided by wisdom. To transgress the laws of our being, in the employment of these substances, leads just as surely to punishment as the violation of any other sanitary or physiological statute. For the offender against the laws of man there may be mercy, but he who outrages the laws which govern his organism meets with inevitable retribution. There is no exception. The punishment may not come to-day, nor to-morrow, but it is none the less sure. If the offense is slight, the punishment is proportionately small. One glass of wine too much may cause a slight headache, two a fever, three an apoplexy. Like everything else capable of producing great good, alcohol can also cause great harm. Our object should be to secure the one, and provide against the other.

ALCOHOLIC BEVERAGES.—The alcoholic liquors of which special mention will be made, are *brandy*, *whisky*, *gin*, *wine*,

and the several *malt liquors*. All these liquids are compounds of alcohol united with water in variable proportions, and also having dissolved in them certain ethers, which give to them what is called the *bouquet*. These ethers undoubtedly exercise a very considerable influence in modifying the effects which would otherwise be produced.

Brandy is manufactured from wine by distillation. Its odor and peculiar flavor are due to a volatile oil which comes over with the spirit. When first made, brandy has the appearance of alcohol, as the coloring matter of the wine remains in the retort. The color which it has when in the market is due to burnt sugar or caramel. The very dark brandies are dosed with a good deal of this substance, and the pale ones with less quantities.

Good French brandy contains about 54 per cent. of alcohol. Even when pure, as a beverage, the use of brandy is not to be commended, as it possesses no advantages over wine, and is apt to produce costiveness. As a stimulant in certain diseases, or in weak persons who cannot take sufficient wine to benefit them, brandy is extremely useful, though for such purposes it is no better than whisky.

But a great difficulty is attendant upon the use of brandy. So generally is it adulterated, that it may be laid down as almost a certainty that, unless the sample can be traced throughout its whole course, from the moment it left the still to the time it is offered for sale, the probabilities are immensely against the fact of its being a pure article. The greater portion of the brandy used in the United States is made here from whisky, and nine-tenths of the rest is manufactured in France or England in the same way. Since the discovery of the methods of manufacturing the essential oils, there is very little difficulty in making a liquor which shall closely resemble brandy, but yet has not the slightest connection with the juice of the grape. Liquors called brandy

are thus made, which are not worth one-tenth as much as brandy. The brandy manufactured from the Catawba grape is perhaps the best which can be ordinarily procured in the American market.

Whisky is the liquor obtained by the distillation of the fermented infusion of rye, corn, wheat, or other grain. It is also prepared, though of an inferior quality, from potatoes. There is not much inducement to adulterate whisky in this country, as it can be manufactured at a very slight cost. The natural impurities which are incident to new whisky are much less evident as the liquor becomes older. Fusel oil is the chief of these, and is present in all whiskies, though to a much greater extent in that made from potatoes than from any other substance. It is also present in larger quantity in those whiskies in which the distillation has been carried to an extent greater than is necessary to obtain a fair quality of liquor. It is a violent poison. I caused a large dog to take one ounce of it into the stomach, from the effects of which death ensued in forty minutes.

Fusel oil may be detected in those spirits which contain it by the addition of a few drops of nitrate of silver, whereby, if the mixture is exposed to the sunshine for a short time, a brown tinge is produced. If no fusel oil be present, no change is effected.

Whisky is an excellent stimulant in low conditions of the system, and undoubtedly exercises a beneficial effect in tuberculous diseases. It is issued to the troops whenever from exposure or excessive labor it is deemed necessary.

Gin is nothing more than whisky prepared from an infusion of rye or barley, to which juniper berries have been added. To the oil of juniper, which comes over with the spirit, it owes its peculiar odor and flavor. This substance also gives gin diuretic properties.

Wine.—Wines differ very much from each other both in flavor and in the quantity of alcohol they contain. It

would be impossible for us to enter into the consideration of the several interesting points connected with the manufacture and chemistry of wines, and we shall have to content ourselves with the chief features in relation to them as alimentary substances.

Wines may be divided into two classes, the *strong* and the *light*. The strong wines, such as port, sherry, madeira, etc., contain from 15 to 25 per cent. of alcohol; the light wines, such as those of France, Germany, and the United States, contain only from 7 to 15 per cent. In addition to alcohol, there are also present in all wines bitartrate of potash and œnanthic ether, to which latter the peculiar odor or bouquet of wine is due.

The physiological effects obtained from wine have already been considered, so far as the alcohol is concerned, but undoubtedly the influence of the ether which they contain is also to be taken into account. The action of wines is something more than would result were they simple mixtures of alcohol and water. The effect is certainly not entirely in proportion to the amount of alcohol they contain, as a glass of champagne exhilarates much more than a similar amount of sherry or madeira, which contain 50 per cent. more alcohol. Neither is the influence limited to exciting the action of the circulatory and respiratory functions or to the retardation of tissue metamorphosis. More than any other alcoholic liquor, wine acts as a soother and restorer, and this, when used in moderation, without the production of any injurious effect. On the contrary, it would appear, from observations which have been made by many distinguished physiologists, that those who drink good wine, with due care to avoid excess, will, other things being equal, live longer and to better purpose than those who entirely abstain. The views of one of the most eminent chemists and physiologists which the world has pro-

duced, Baron Liebig,* upon this subject are so apposite that I subjoin them without a further discussion of the point.

"As a restorative, a means of refreshment, when the powers of life are exhausted, of giving animation and energy where man has to struggle with days of sorrow, as a means of correction and compensation when misproportion occurs in nutrition and the organism is deranged in its operations, and as a means of protection against transient organic disturbances, wine is surpassed by no product of nature or of art.

"The nobler wines of the Rhine, and many of those of Bordeaux, are distinguished above all others by producing a minimum of injurious after-effect. The quantity of wine consumed on the Rhine by persons of all ages, without perceptible injury to their mental and bodily health, is hardly credible. Gout and calculous diseases are nowhere more rare than in the district of the Rheingau, so highly favored by nature. In no part of Germany do the apothecaries' establishments bring so low a price as in the rich cities on the Rhine, for there wine is the universal medicine for the healthy as well as the sick; it is considered as milk for the aged."

The wines of the United States, which are scarcely surpassed, many of them, in delicacy of flavor and freedom from deleterious substances by the best wines of Europe, are undoubtedly destined to take the place of the noxious compounds which are now in use as whisky and brandy. When it is possible for us to become a wine-drinking, instead of a spirit-drinking people, there will be no further occasion for prohibitory liquor laws.

For hospital use, when it is necessary to produce rapid and full stimulation, they do not answer, owing to their deficiency in alcohol. The only wine, until recently, used

* Familiar Letters on Chemistry, etc., p. 454.

in the military hospitals was sherry. Port was stricken from the supply table owing to the great difficulty of obtaining it pure; but within the last few months a very excellent wine, Tarragona port, has been used, which appears to fulfil all the objects of port wine. It is full bodied, sweet, and sufficiently astringent.

The adulterations of wines are very numerous, and constitute altogether too extensive a subject to be properly discussed in any other work than one specially devoted to their consideration.

Malt Liquors.—Under this head are included ale, porter, and the several kinds of beer which are made from malt and hops. They are in chemical characteristics similar to wine, as they are produced from the fermentation of vegetable juices.

In their influence upon the human organism, malt liquors are noted for producing more of a sedative than a stimulant effect. As exciters of the appetite and as slow but certain tonics, they are perhaps more valuable than wine. Böcker,* who experimented in regard to the influence of German beer, found the principal effect to be an increase in the amount of chloride of sodium excreted in the urine.

Malt liquors, when well made and unsophisticated, are wholesome beverages. It often happens, however, that they are not properly prepared, and, moreover, that they are adulterated with deleterious substances. One of the most common, as it certainly is one of the most injurious articles used to adulterate malt liquors, is cocculus indicus. It is said that strychnine and opium are also sometimes added to beer. I do not think this is the case in this country.

Malt liquors contain from 4 to 7 or 8 per cent. of alcohol.

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* Ueber die Wirkung des Biers auf den Menschen. Archiv des Vereins für Gemeinshaftliche Arbeiten, u. s. w., 1854, Band i. p. 544.

TEA AND COFFEE.—It is a somewhat remarkable circumstance that the active principles of both these substances should be identical in composition, thein and caffein differing in no respect from each other. But although this is the fact, the effects of tea and coffee upon the human organism, though similar, are yet sufficiently different for us to draw a distinction between them.

Tea is the leaf of a plant growing in China and Japan. Coffee is the fruit of a tree originally found in Arabia and tropical Africa, but now growing in the East and West Indies and South America, to which regions it has been introduced by man.

Tea is prepared for use as a beverage by making an infusion with water of the dried leaves. Coffee is made into a drink by boiling the roasted and ground berries. In both, the active principles are yielded; but through the roasting process which the coffee has undergone a volatile oil has been developed, and the conversion of the caffein into other compounds effected. Coffee, as we use it, is very different from the liquid procured by acting on the unroasted berries with boiling water. Tea is more astringent than coffee, on account of the large amount of tannic acid which it contains, a substance not found in coffee.

The effects of tea upon the organism have been studied with a good deal of thoroughness. Böcker* has investigated this subject with his customary accuracy and devotion. He found that under the influence of tea the products of the destructive metamorphosis of tissue ordinarily excreted from the body were very materially reduced in quantity. My own experiments† are confirmatory of those of Böcker in most respects. In lieu of water, I took thirty-two ounces

* Versuche über die Wirkung des Thee's auf den Menschen. Archiv des Vereins, etc. Band I. 1854, p. 213.

† Physiological Memoirs, p. 17 et seq.

of strong tea per day, sixteen ounces at breakfast and sixteen at tea. Through the influence of this substance the mental faculties were rendered much more active, the pulse was increased in frequency, and there was a strong desire for bodily exercise, which it was difficult to repress. At night all these phenomena were increased in intensity, and there was a great indisposition to sleep. They generally lasted five or six hours after drinking the tea. Previous to these experiments I was not in the habit of drinking tea.

Upon tissue metamorphosis the influence of the tea was well marked. The amount of urine and the proportions of its solid constituents were diminished, and this notwithstanding the increased quantity of nitrogen ingested and the additional exercise of the mind, which unavoidably attended the use of tea.

The effects of coffee, as has been said, are somewhat different. Julius Lehmann,* who has experimentally studied the subject, endeavored to separate the phenomena observed after drinking coffee into two classes—those due to the empyreumatic oil, developed during the roasting process which the coffee has undergone, and those consequent on the presence of caffein. In this he was only partially successful; but it is very evident that, as he observes, coffee produces two groups of effects which it is difficult to reconcile—the exciting influence upon the brain and nervous system, and the power it possesses of limiting the destructive metamorphosis of the tissues.

The results which I obtained from my own experiments,† so far as related to the quantity of urine and proportions of its constituents, were not materially different from those which followed the use of tea. I found, however, that the

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* Über den Kaffee als Getrank, u. s. w. Annalen der Chemie und Pharmacie, B. lxxxvii. p. 205.

† Physiological Memoirs, p. 25.

influence upon the mind was much greater, and that an amount of mental labor could be undertaken, without fatigue, after the ingestion of a cup or two of strong coffee, which could not otherwise be endured without great exhaustion being produced. Every one in the habit of drinking coffee must have noticed this effect, and many have doubtless availed themselves of the knowledge, by taking an extra cup when they had an amount of intellectual labor to go through with which they desired to do well.

The use of tea and coffee in armies cannot be too highly commended. Both are issued to the soldiers of the United States army, and in quantities sufficient to make good and wholesome beverages. I have often had occasion to notice the excellent effects produced on soldiers who, after long and fatiguing marches, perhaps during rain and snow, reached camp well-nigh exhausted. Tired both in mind and body, they went into their tents or about the fatigue duties of the camp sullen and quiet. Scarcely had they taken their coffee, than their whole demeanor was changed. Singing, laughing, and lively conversation took the place of their previous moroseness, and they went to bed happy and refreshed. Baudens* says that coffee is preferred by the French troops in the field to any other beverage, and that it prevents the intestinal diseases so frequent in hot climates.

Macleod,† in considering the subject of the food of the British army in the Crimea, says:—

"I have little doubt that, if the precaution had been taken to supply the troops every morning with hot coffee as they went in or returned from duty, which was a step strongly recommended as a prophylactic at Walcheren, much of our mortality might have been avoided. It can

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* La Guerre de Crimée, p. 51.

† Notes on the Surgery of the War in the Crimea, etc., p. 34.

hardly be doubted that this could have been accomplished at the worst of times by a little management, as there are few things more portable or more easily prepared than coffee. The Turks place great reliance on this beverage as a preservative against dysentery, and the French preferred its use in their army to the tea, which we employed. If we were ordered to prescribe a dietary, the best adapted to give rise to gastric irritation and dyscrasial disease, could we suggest one more potent than salt pork, hard biscuit, and raw rum?"

Nothing can be better for the system, in the way of food, before the troops go to any work in the morning, than coffee. It not only invigorates the body and lightens the mind of its cares, but it serves to render the organism much less susceptible to diseases, especially those of malarious origin. Almost any article of the ration could be better dispensed with than coffee, and men will be content for a long time with hard bread and salt pork, if they can be supplied with a sufficient quantity of this beverage.

Tea and coffee are both subject to adulteration. The tea leaf is perfectly characteristic, and, when once it is thoroughly recognized, no difficulty exists in detecting the false leaves. The coffee berry cannot be adulterated, unless in its ground state, as its form, color, and other features are such as admit of easy verification; but when roasted and ground, it is readily sophisticated, and advantage is very generally taken of this fact by dishonest dealers to impose upon the community.

The tea leaf is in width about one-third its length; the margins are serrated. In the large leaves the serration is well marked, and all the veins proceeding from the central part of the leaf form a series of loops as they approach the margin. Microscopically examined, the tea leaf is seen to be covered on its under surface with short and pointed hairs. The stomata are also met with, principally on the

under surface of the leaf, and are formed by two semi-ovoidal cells, which unite at their extremities, so as to leave an aperture between them. By macerating the tea leaves in water for a day or two, it becomes very easy to examine it by simple inspection or by the microscope. I have frequently found willow leaves and grass in low-priced teas, and many other kinds of leaves are used for the purpose of adulteration.

Tea leaves which have been already used are often dried and again put in the market. They can only be detected by the weakness of the infusion they make, or by chemical examination.

Black tea is much more wholesome than green, as the latter is always artificially colored, and is frequently dusted with catechu, black-lead, ferrocyanide of iron, turmeric, etc. Green tea should be altogether condemned as a beverage. The leaf differs naturally in no respect from that of black tea, the peculiar color and other qualities depending on the substances with which it has been coated.

Ground coffee is extensively adulterated with chicory—a species of dandelion—rye, corn, acorns, leaves, etc. It is difficult to detect these substances, unless by microscopical examination or by drinking the infusions prepared from coffee containing them. In the latter case, no one acquainted with the rich, aromatic flavor and odor of genuine coffee will fail to perceive the difference, if any of the substances mentioned have been used. What is known as dandelion coffee is almost altogether free from coffee, and consequently possesses but in a very slight degree any of the beneficial properties of the genuine article.

For the detection of the adulterations of coffee the microscope is necessary. By becoming familiar with the structure of the berry, no difficulty will be found in recognizing any extraneous substances.

TOBACCO.—Without going into the consideration of the

botany and history of tobacco, it will be sufficient to say that it is the leaf of the Nicotiana, a plant belonging to the family Solanaceæ, to which also the potato belongs. There are three species of it known, all of which yield leaves which are used by man to minister to his wants.

It has been so customary for writers to decry the use of tobacco, that it may appear strange that a plea should be urged in its behalf. But that it is capable of doing good to many, when employed in moderation, does not I think admit of doubt. If we look in the arguments of those who, from King James the First of England to the last who has condemned it, for any evidence of the truth of their allegations, we shall find little to satisfy us. The tirades have generally been written by those who knew nothing of the human frame, or of the effects of tobacco upon it; and even the few educated medical men who have given us their views against it, have never attempted to show, by experiment, its influence upon the human organism, when used with that moderation so becoming to us in all things. It is true the active principle of tobacco is a violent poison, but, as we have already seen, so are the essential matters of many other substances which we use as food without hesitation. It is the abuse of tobacco which is to be condemned, and not the moderate employment of it, which, so far from being injurious, is, on the contrary, decidedly beneficial in the majority of instances.

The experiments which I some time since performed upon myself,* with reference to the effects produced by tobacco, were sufficient to satisfy me of its great value as an article of "accessory food." The word food, as we have already intimated, is to be used hygienically in its largest sense, and is not to be restricted to embrace only those substances which are taken into the stomach to be digested,

* Physiological Memoirs, p. 59.

and thus to enter the blood. In the proper view of the subject, oxygen is as much food, though it enters the system through the lungs, as is nitrogen, which enters it in bread through the alimentary canal; and in this view it is that I employ it with reference to tobacco, which enters the organism through the air-passages, or by absorption from the mucous membrane of the mouth.

The experiments, which were conducted with great care, and during which I smoked 450 grains (nearly two cigars) of tobacco daily, continued for five days. The food, exercise, etc. remained as in a former series of investigations, during which no tobacco was used, and during which the weight of the body was maintained at its ordinary standard. The results were, that I gained ·07 of a pound in weight, and that some of the products of tissue metamorphosis were increased in quantity and some diminished. The phosphoric acid, for instance, was very considerably augmented, and the urea lessened. In a subsequent series, in which the food was insufficient to prevent the body losing weight, tobacco, used as before, lessened the rate of loss. The effects upon the excretions were similar to those previously observed.

The effects upon the circulatory and nervous systems were very apparent. The pulse was increased in frequency, and there were slight, irregular actions of the muscles of the eyelids, mouth, and upper extremities. The mind was clear, and there was no headache. These sensations were succeeded by a pleasant feeling of ease and contentment, which lasted about two hours. During the first part of the night there was wakefulness, but this was always succeeded by a sound and refreshing sleep. The appetite was unaffected.

From both sets of investigations I concluded—

1st. That tobacco does not materially affect the excretion of carbonic acid through the lungs.

2d. That it lessens the amount of aqueous vapor given off in respiration.

3d. That it diminishes the amount of the feces.

4th. That it lessens the quantity of urine, and the amount of its urea and chlorine.

5th. That it increases the amount of free acid, uric acid, and phosphoric and sulphuric acid eliminated through the kidneys.

As a soother to the mind and a promoter of reflection, tobacco is entitled to great consideration; and I am decidedly of the opinion that it is beneficial to those who, like soldiers, have a great deal of mental and bodily fatigue to undergo. It quiets the troubled mind, and disposes it to look with calmness on the ills which may bear harshly upon it. But these remarks only apply to the moderate use. When employed to excess, there is no doubt that it predisposes to neuralgia, vertigo, indigestion, and other affections of the nervous, circulatory, and digestive organs. Chewing should be altogether discarded on account of the great loss it causes in saliva, and also because it is a filthy practice. Smoking is the only way of using tobacco which should be practiced, and cigars, on account of their greater mildness, are preferable to pipes.

But one of the best effects of tobacco, when used, as it ought to be, only after meals, is that which it produces over the secretion of gastric juice. It is very certainly established that any stimulant substance which increases the amount of saliva increases likewise the quantity of gastric juice. To prove this it is only necessary to make a gastric fistula in a dog, and to place strongly sapid substances, such as vinegar, aloes, or tobacco, in the mouth. Although no gastric juice may be issuing from the tube in the fistula, no sooner is the substance placed in the mouth and the effect produced on the saliva than the gastric juice begins to flow until a very considerable quantity has

escaped, or as long as the action in the mouth continues. The beneficial influence of an after-dinner cigar is therefore important as aiding materially in the digestion of the food.

CHAPTER XXVII.

ALIMENTATION OF THE SOLDIER.

Having passed in review the principal substances which are used as food by man, the qualities which belong to them, and the part which they severally perform when ingested into the system, we come in the next place to apply to the alimentation of the soldier the facts and opinions set forth.

When we consider the arduous nature of his service, the exposure to which he is often subjected, the deprivations he is obliged to undergo, and the necessity which exists for providing by all possible means for his well-being and comfort, we see at once how important it is that the food of the soldier should receive special attention from those who are charged with the important duty of attending to his subsistence. Governments have at all times recognized this necessity to some extent, but it is only lately that the subject has been considered as one of vital interest, and that inquiry has been made in the right direction as to how the food of the soldier can be best made available for his wants, and of such a character as will enable him most fully to accomplish the labor which is expected of him.

But, as generally happens in such cases, it was only after a long series of disasters that the minds of those having the power were brought to understand the necessity of

providing more generously for the subsistence of those who risk their lives in the service of the state. Scurvy, fever, intestinal diseases, debility, and other affections continued for ages to increase the sickness and death rates of armies before it was deemed worth while to supply a more nutritious diet to the soldier; and even now there are nations which leave the feeding of their armies in a great degree to the whim or caprice of the officers immediately in command.

Perhaps no event of modern times has had more influence in causing right views to prevail in regard to this matter than the war between the Allies and Russia, which was mainly conducted in the Crimea. We have already seen how great was the suffering of the allied forces in respect to shelter; how they died from the poisons generated within their own bodies, and languished in hospitals from which air and light were in great measure excluded. It will prove equally profitable to us if we consider the evils which resulted from food deficient either in quantity or quality. Macleod,* in referring to this subject, says:—

"The food provided for the army during the first winter and spring was defective both in quantity and quality. This arose partly from unavoidable circumstances and partly from inexperience in the officers to whose care was intrusted the supply of the army. Salt meat and biscuit constituted the bulk of the distribution, while rice, coffee, and sugar were occasionally but sparingly added. Sir Alexander Tulloch says that during December, January, and February 'there was almost a total absence of fresh meat, and even the sick were for many days, nay, even for weeks, fed exclusively on salt meat, in their state a poison.' The coffee, being served out raw and unground, was all but useless, and the ration salt pork was not always of the best. * * * * * * * * *

* Op. cit., p. 33.

"Men severely worked and constantly in a keen air require to have their physical energies sustained by a liberal supply of such food as contains the largest amount of nourishing and staple ingredients; but in place of that the supply to our troops, besides being irregular in amount, was insufficient for their support, and those constituents which were most calculated to provide for their necessities were reduced at the very time when they were most required. Thus, in November, the ration of biscuit and that of rice were altogether stopped, so that within one week the troops were, in most cases, deprived of nearly half a pound of the vegetable and farinaceous food so much required to counteract the salt meat diet, and this, too, when scurvy had made its appearance."

These remarks, and others which Dr. Macleod makes on the same subject, apply only to the earlier part of the war, as matters were so very much improved subsequently that he gives it as his opinion that in the whole history of warfare no army ever fared so well as did the British.

The following table, prepared by Dr. Christison, exhibits the quality of the food and the proportion of carbonaceous and nitrogenous principles ingested daily by the British soldier in the Crimea.

	Ounces of nutritive principles.	Whereof there is—	
		Carboniferous.	Nitrogenous.
1 lb. salt meat, 1 lb. biscuit, 2 oz. sugar, ... Coffee not used; rice uncertain; beer none.	23·52	16	6·92

It needs no argument to show the insufficiency of such a diet, which contained at least five ounces less of nutritious

principles than will suffice to maintain a soldier in a good condition of health. Its deficiency is strongly pointed out in the following extract.*

"During the following month (January, 1855) the position of the soldier was one of increased difficulty and hardship; the efficiency of the whole army was seriously compromised—there was scarcely a man in the ranks who had not fallen into a low, cachectic, reduced condition. Disease was simply the more overt manifestation of a pathological state of the system which was all but universal, and merely indicated the worst grades of it; fever and affections of the bowels represented the forms in which morbid actions were usually presented; and while gangrene and scurvy, occurring as complications, indicated too clearly those privations and that exposure from which these diseases were mainly derived, the absence of those inflammatory affections of the pulmonary organs—of parenchymatous structures and serous membranes—of articular inflammatory rheumatism, so constantly prevalent in cold climates under ordinary circumstances of life, suggested irresistibly the conclusion that the effects must have experienced such a complete diversion from their ordinary form of expression, in deference to a cachectic state of the body, and a vitiated and depraved state of the circulating fluids."

In the French army the case was no better. Jacquot† says that the alimentation of the French troops was defective in quantity, for the soldiers used their money for the purchase of vegetables, which they bought of the merchants of Kamiesch, of the sutlers, the English, and even the Piedmontese. During the winter of 1855–56, when the

* Medical and Surgical History of the British Army which served in Turkey and the Crimea during the War against Russia, etc., vol. ii. p. 35. Presented to both Houses of Parliament by command of Her Majesty. 1858.

† Du Typhus de l'Armée d'Orient, p. 85 et seq.

disastrous epidemic of typhus prevailed, the soldiers received bread but one day in three. The biscuit issued was difficult of mastication, especially by those affected with scurvy, and when macerated it became pasty, mawkish, and heavy. The intestinal juices acted upon it with difficulty; it was indigestible, gave rise to fluxes, and passed from the bowels in large pieces, unaffected by the digestive process. The meat was also of bad quality, and vegetables were rarely issued, either fresh or preserved. The alimentation of the French soldier was therefore deficient both in quantity and quality. No doubt can exist that the typhus fever which raged in the French army owed its origin, in great part, to the bad character of the food.

Cazalas* states that the alimentation of the French army in the Crimea was often insufficient, and always of medium or bad quality.

In our own service, it has frequently happened that the troops have suffered from the effects of food not perfectly adapted to maintain the body at a fair standard of health. Scurvy from a deficient amount of vegetables or fresh meat, intestinal diseases from indigestible food, and fevers due to an impoverished or toxic state of the blood consequent on innutritious aliments, have frequently prevailed, when, with such care as could readily have been bestowed, they might have been prevented.

So far as the ration of the American soldier is concerned, it has always compared most favorably with that of foreign troops. Thus the ration of the British soldier is, when at home stations, 16 ounces of bread and 12 ounces of uncooked meat; at foreign stations it is 16 ounces of bread or 12 ounces of biscuit and 16 ounces of meat, fresh or salt. This is charged to the soldier at 3½*d.* per day abroad, or 4½*d.* per day at home. Coffee, sugar, pepper, potatoes, salt,

* Maladies de l'Armée d'Orient, etc., p. 38.

or whatever else he may need, is purchased by himself from his own funds. It costs the British soldier, therefore, about 8½*d.* per day for his food, which sum is to be deducted from his pay. In the Crimea, however, it was found necessary to deviate from this standard, and there were issued to each soldier daily—

	Pounds.	Ounces.
Bread	1	8
or		
Biscuit	1	0
Meat, fresh or salt	1	0
Rice	0	2
Sugar	0	2
Coffee	0	1
or		
Tea	0	¼
Lime-juice	0	1
Salt	0	½ } for every 8 men.
Pepper	0	¼ } for every 8 men.
Rum	0	gall. $\frac{1}{32}$

The deficiency here was in meat and vegetables. The amount of coffee is not enough to make a sufficient quantity of a good beverage.

For this ration a stoppage of 4½*d.* was made daily against each soldier.

At several foreign stations, as Hong Kong and the Cape of Good Hope, rice, sugar, coffee, and salt are issued as component parts of the rations, but not in large enough quantities, and in all, with the exception to be mentioned, fresh vegetables are not supplied. There is no evidence, that I can find, tending to show that the British soldier is required to cultivate gardens, as is done with such excellent results at all the garrisoned posts of the United States army.

There is no doubt that the allowance of meat in the ordinary ration of the British soldier is altogether too small, and that of bread can scarcely be regarded as sufficient. The plan, too, of requiring the men to purchase their own coffee, sugar, potatoes, etc. is exceedingly objectionable, and

it is strange that the precarious nature of such a source of supply has not more fully attracted the attention of the British Government, which, since the Crimean war, cannot justly be accused of indifference for the welfare of its troops.

In India it would appear that the British soldier is better fed than at other stations. His daily allowance of food is—

	Pounds.	Ounces.
Bread	1	0
Meat	1	0
Vegetables	1	0
Rice	0	4
Sugar	0	$2\frac{1}{2}$
Tea	0	$0\frac{3}{7}$
Coffee, when tea is not used	0	$1\frac{3}{7}$
Salt	0	1
Wood	3	0

It is provided that the meat shall be cut up into joints, and that those parts of which more than two-thirds are bone, such as the ribs, shins, etc., shall be excluded. Mutton is issued twice a week in lieu of beef, and the bread is of the best quality.

This is a very liberal diet, and one with which little fault can be found. It is perhaps deficient, or would be in our climate, in bread and meat.

The French ration in the Crimea was—

	Pounds.	Ounces.	Drachms.
Bread	1	10	7
and			
Biscuit	0	3	$8\frac{3}{8}$
or			
Biscuit	1	6	$14\frac{3}{8}$
Fresh beef	0	10	$9\frac{1}{8}$
or			
Salt pork	0	8	$7\frac{1}{2}$
Rice or beans	0	2	$1\frac{3}{4}$
Salt	0	0	9
Coffee	0	0	9
Wine	0	0	gill, $1\frac{3}{4}$
or			
Brandy	0	0	gill, $0\frac{7}{16}$

The deficiency here is in meat, which in quantity is not more than half what it ought to be. The coffee and sugar are also by no means given in sufficient amount. In time of peace, the ration of the French soldier is not so large as above stated.

The ration of the Russian soldier is—

1 pound of black bread.
1 pound of meat.
1·1 quarts of kwass, a kind of beer.
3½ gills of sauerkraut.
3½ gills of barley.
12½ drachms of salt.
3·86 grains of horse-radish.
1¾ gills of vinegar.
3·86 grains of pepper.*

This is by no means a bad diet, but the bread and meat are not in sufficient quantity.

The American soldier is better fed than any other in the world. The ration, as established by law, consists of—

	Pounds.	Ounces.
Bread or flour	1	6
Fresh or salt beef	1	4
or		
Pork or bacon	0	12
Potatoes	1	3 times per week.
Rice	0	1·6
Coffee	0	1·6
or		
Tea	0	0·24
Sugar	0	2·4
Beans	0	0·64 gill.
Vinegar	0	0·32 "
Salt	0	0·16 "

In addition to the above, 1 pound of sperm candles, or

* These examples are taken from the Report of the Commission appointed to inquire into the regulations affecting the Sanitary Condition of the Army, etc. Parliamentary Documents, 1858, p. 425 et seq.

1¼ pounds of adamantine candles, or 1½ pounds of tallow candles, and 4 pounds of soap are issued to each 100 rations. Pepper has been recently added to the ration.

Extra issues are made of pickles and fruits, sauerkraut, and other vegetables whenever in the opinion of the medical officers they are necessary to the health of the troops; and one gill of whisky is allowed in cases of excessive exposure and fatigue.

Whenever it is practicable for the troops to bake their own bread, flour is issued. Twenty-two ounces of flour, if properly baked, will make about thirty ounces of bread. The surplus flour is resold to the Government at the cost price, and thus a fund is formed by each company, which is used for the purchase of such additional articles of food or comfort as may be desired. In time of peace, company gardens are cultivated at every military post, so that it scarcely ever happens that there is any deficiency of food, either in quantity or quality. Fresh meat is issued as often as the commanding officer may direct—generally about four times a week.

Since the commencement of the present rebellion, the armies of the United States have been fed as no armies have ever been fed before in time of war. This is proven by the healthy condition of the troops, wherever the influence of a bad climate has not been in force. Scurvy, for instance, one of the first diseases to make its appearance when the food is of inferior quality, has prevailed to so slight an extent that the occurrence of an occasional case excites attention. When we compare the condition of our troops, in this respect, with that of other nations during extensive warlike operations, we may well congratulate ourselves on the difference.

After providing that the food shall be nutritious, the next point to attend to is to insure due variety. Even the first consideration is scarcely more important than this, and

no pains should be spared to render its accomplishment certain. Few facts in physiology are more completely established than that relative to the absolute necessity of varying the quality of the food. No matter how nutritious it may be, it is far better to change it for food even less nutritious than to continue an unvarying sameness.

Sick Soldiers.—The diet of the sick soldier should not vary essentially from that of invalids in civil life. It should be divided into several classes, according to the conditions of the patients. Too much attention cannot be paid to this subject by the medical officers in charge of military hospitals. More, much more good will be accomplished by providing fresh air, plenty of light, and suitable food than by any system of medication which can be adopted. It is not my purpose to underrate the proper use of medicinal agents. I am fully sensible of their value—but that too much medicine is given and too little attention paid to hygiene, there can be no doubt.

In order that it may be shown what are the diets in use in the military establishments of Europe, I subjoin the diet tables of the British army, navy, and Indian service, which are more liberal than those in force in continental hospitals. The diet table of the United States army general hospitals is also given. The English soldier is now, when sick, better fed and cared for than the soldiers of any European nation. It will be seen, from a comparison of the tables given with that of the United States army hospitals, that every care has been taken to provide that the diet in use in the latter shall be of good quality, in sufficient quantity, and varied, so as to meet the requirements of physiology and hygiene.

EXTRACT FROM THE INSTRUC

A Scheme of Diet for Patients in the Royal

Full Diet.		Half Diet.	
Bread.................................lb.	1	Bread.................................lb.	1
Beef or mutton.......................lb.	1	Beef or mutton.......................oz.	8
Potatoes or greens...................lb.	1	Potatoes or greens...................oz.	8
Herbs for broth.................drms.	25	Herbs for broth.................drms.	25
Barley..............................drms.	14	Barley..............................drms.	14
Salt..................................drms.	8	Salt..................................drms.	8
Vinegar.............................drms.	16	Vinegar.............................drms.	16
Tea...................................drms.	4	Tea...................................drms.	4
Sugar................................drms.	16	Sugar................................drms.	16
Milk for tea.........................pt.	⅓	Milk for tea.........................pt.	⅓
Broth..................................pt.	1	Broth..................................pt.	1
Home beer (small)................pts.	2	Home beer (small)................pts.	1½
Or strong.............................pts.	1½	Or strong.............................pt.	1
Beer for servants, viz.:		Foreign wine, at the surgeon's discretion, not exceeding......pt.	1
Nurses.................................pts.	1½		
*Overseers of washers, washers, and attendants on lunatics..pts.	2		
Foreign wine, not exceeding....pt.	1		
Or porter, not exceeding........pts.	1½		
At the surgeon's discretion.			
Veal, Fowls, Fish.—Such quantities, in lieu of beef and mutton, as the medical officers may prescribe.			
Rice or Flour Pudding.—At the discretion of the medical officers, to patients on low or fever diet only.			

* Laborers, seamstresses, and scrubbers, etc. to have *2d.* a day, in lieu of beer; and the matron, porter, and butler *10d.* a day, in lieu of rations.

N.B.—As this Scale provides liberally for each class of patients, medical officers are carefully to avoid all deviations from it, as their duty toward the sick may permit. Such patients (not exceeding six) as may be inclined, are to be admitted to attend the weighing, measuring, etc. of the provisions in the morning, and serving them out when cooked.

NOTE.—Two drachms of Souchong tea, 8 drachms of Muscovado sugar, and one-sixth part of a pint of genuine milk, to be allowed to each patient for a pint of tea, morning and evening.

The meat for the full and half diet is to be boiled together, with 14 drachms of Scotch barley, 8 drachms of onions, 1 drachm of parsley, and 16 drachms of cabbage for every *pint of broth;* or at the discretion of the medical officers, 8 drachms of carrots and 8 drachms of turnips, in lieu of the cabbage, which will make a suffi-

TIONS FOR NAVAL HOSPITALS.

Naval Hospitals and Marine Infirmaries.

Low Diet.		Fever Diet.	
Bread ....oz.	8	Bread ....oz.	8
Herbs for broth................drms.	12½	Or sago.....................................oz.	4
Barley ....drms.	7	Tea ....drms.	4
Salt..................................drms.	8	Sugar....... .... drms.	20
Tea....................................drms.	4	Milk for tea..............................pt.	⅛
Sugar................................drms.	16	Milk for diet ....pt.	¼
Milk for tea..............................pt.	⅛		
Milk for diet.............................pt.	1		
Broth..pt.	½		

cient quantity of good broth to allow a pint to each on full and half diet, and half a pint to each on low diet.

Rice pudding.—Each to contain—

Rice..	8 oz.
Sugar..	1 oz.
Milk..	¾ pint.
Eggs..	1
Cinnamon..	1 blade.

Flour pudding.—Each to contain—

Flour..	4 oz.
Sugar..	1 oz.
Milk..	¾ pint.
Eggs..	1
Ginger...	A few grains.

EXTRACT FROM THE BENGAL MEDICAL REGULATIONS.

Table of Diets for Hospitals of European Troops.

Full diet.	Half diet.	Low diet.	Milk diet.	Spoon or fever diet.
BREAKFAST.				
Tea, ½ oz. Bread, 1 lb. Butter, 1 oz. Sugar, ½ oz.	Tea, ½ oz. Bread, 1 lb. Butter, ½ oz. Sugar, ½ oz.	Tea, ½ oz. Bread, 8 oz. Sugar, ½ oz.	Tea, ½ oz. Bread, 1 lb. Butter, ½ oz. Sugar, ½ oz.	Tea, ¼ oz. Sugar, ¼ oz.
DINNER.				
A pint of broth, with barley, greens, and onions, and 1 lb. of meat, either mutton or beef.	A pint of broth, with rice, barley, greens, or onions, and 8 oz. of mutton, of good and edible quality, or a pint of chicken soup, with vegetables, as above; a chicken or half a fowl, weighing, when ready for being dressed, not less than 8 oz.	A pint of mutton or chicken broth.	A pint of milk (new) or a pint of rice and milk, with ½ oz. of sugar.	Bread ½ lb., to be made into panada or pudding, or 4 oz. of sago.
SUPPER.				
A pint of rice-gruel, with ½ oz of sugar, seasoned with ginger or nutmeg, and a glassful of wine, should any be allowed.	The same as full.	The same as full.	The same as dinner.	The same as breakfast.

In specifying the quantity of each item of meat for the several kinds of diet, it is to be distinctly understood that meat in a raw state is intended, and not meat which has been already boiled.

Articles composing the different kinds of Diet for a Day—Avoirdupois Weight.

Full diet.	Half diet.	Low diet.	Milk diet.	Spoon diet.
Meat, 1 lb., either beef or mutton. Bread, 1 lb. Butter, 1 oz. Milk, 1 meas. Sugar, 1 oz. Tea, ½ " Rice, 4 oz. for gruel and congee water. Salt, ½ oz. Onions, 1 " Pepper, 1 dr. Ginger, ½ " Nutmeg, ½ " Barley, ½ oz. Flour, ½ " Firewood, 2 seers.	Mutton, 8 oz. of good and edible quality, or half a fowl or a chicken. Bread, 1 lb. Butter, ½ oz. Milk, 1 meas. Sugar, 1 oz. Tea, ½ " Rice, 4 oz. for gruel or congee water. Salt, ½ oz. Onions, 1 " Pepper, 1 dr. Ginger, ½ " Nutmeg, ½ " Barley, ½ oz. Flour, ½ " Firewood, 2 seers.	Mutton, 8 oz. for preparing broth, or a chicken for broth. Bread, 8 oz. Milk, 1 meas. Sugar, 1 oz. Tea, ½ " Rice, 4 oz. for gruel or congee water. Salt, ½ oz. Onions, 1 " Pepper, 1 dr. Ginger, ½ " Nutmeg, ½ " Barley, ½ oz. Flour, ½ " Firewood, 2 seers.	Bread, 1 lb. Milk, 2 pints and 1 measure for tea. Butter, ½ oz. Sugar, 1½ " Tea, ½ " Rice, 6 oz. for rice or congee water. Salt, ½ oz. Firewood, 2 seers.	Bread, 8 oz., or 4 oz. sago. Sugar, 1½ oz. for tea, sago, or panada. Tea, ½ oz. Milk, 2 measures for tea and panada. Salt, ½ oz. Nutmeg, ½ dr. Rice, 2 oz. for congee water. Firewood, 2 seers.

N.B.—The half of a fowl or chicken in the above "half diet" is to weigh 8 oz., exclusive of bone.

The undermentioned vegetables shall be considered as part of the authorized hospital dietary, for full and half diet; the kind and quantities of those articles to be employed for that purpose being left to the discretion of medical officers, and included as extras in the separate statements furnished by them, and which are to be subject to check and counter signature, as heretofore, by superintending surgeons. It is to be understood that the quantity noted opposite each article is intended only as the maximum to be allowed to one man on one day.

	Half.	Full.		Half.	Full.
Potatoes	½ lb.	¾ lb.	Yams	½ lb.	¾ lb.
Pumpkins	½ "	1 "	Ram-tooraees	½ "	¾ "
Cauliflower	½ "	1 "	Turnips	½ "	1 "
Cabbage	½ "	1 "	Carrots	½ "	1 "
Sweet potatoes	½ "	¾ "			

The issue of such fruits as may be procurable is also sanctioned, when considered actually necessary, to the sick in hospital of European corps, by the commissariat, on a separate requisition from the medical officer, countersigned by the superintending surgeon.

DIET TABLE.

BRITISH MILITARY HOSPITALS.—*Articles composing the different Diets for a Day—Avoirdupois Weight.*

Tea.	Spoon.	Beef tea.	Milk.	Low.	Chicken.	Half.	Fish.	Roast (half.)	Entire.
Bread, 8 oz. Tea, ½ " Sugar, 2½ " Milk, 6 "	Bread, 8 oz. Tea, ¼ " Sugar, 1½ " Milk, 6 " Also— Arrow-root, 2 " Sugar, 1 "	Bread, 12 oz. Tea, ¼ " Sugar, 1½ " Milk, 6 " Beef, 8 " Salt, ½ "	Bread, 14 oz. Rice, 2 " Milk, 8 pts. Sugar, 1 oz.	Meat, 8 oz. Bread, 14 " Salt, ½ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Butter, 1 " ——— Rice, 2 " Milk, ¾ pt. Sugar, ½ oz. Egg, 1 " For pudding, flavored with cinnamon, lemon.	Flour, 8 oz. Bread, 18 " Salt, ½ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Butter, 1 "	Meat, 8 oz. Bread, 16 " Potatoes, 8 " Barley, 1½ " Salt, ¾ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Vegetables, 4 " Butter, 1 " Flour, ¼ "	White fish, 8 oz. Bread, 18 " Potatoes, 8 " Salt, ¾ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Butter, 2 "	Roast meat, chop, or steak. ——— Meat, 8 oz. Bread, 18 " Potatoes, 8 " Salt, ¾ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Vegetables, 4 " Butter, 1 "	Meat, 12 oz. Bread, 16 " Potatoes, 16 " Barley, 1½ " Salt, ¾ " Tea, ¼ " Sugar, 1½ " Milk, 6 " Vegetables, 4 " Butter, 1 " Flour, ¾ " ——— When meat—roasted, baked, or stewed— Bread, 18 ounces, (being 2 oz. extra,) in lieu of barley and flour. To be marked "varied" on Roll.

BREAKFAST.									
Tea, 1 pt. Bread,	Tea, 1 pt. Bread, 4 oz.	Tea, 1 pt. Bread, 4 oz.	Milk, 1 pt. Bread, 6 oz.	Tea, 1 pt. Bread, 5 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "
DINNER.									
Tea, 1 pt. Bread,	Arrow-root.	Beef tea, 10 oz. Bread, 4 oz.	Rice milk, 1 pt. Bread, 4 oz. Sugar, 1 "	Beef tea, 15 oz. Bread, 4 " Also— Rice pudding.	Fowl, 8 oz. Either roasted or made into chicken tea—12 oz. Bread, 6 oz.	Soup, 15 oz. Meat, 8 " Bread, 4 " Potatoes, 8 "	Fish, 8 oz. Bread, 6 " Potatoes, 8 " Butter, 1 "	Roast meat, chop, or steak. Meat, 8 oz. Bread, 6 oz. Potatoes, 8 " Vegetables, 4 "	Soup, 1 pt. Meat, 12 oz. Bread, 4 " Potatoes, 16 " When meat—roasted, baked, or stewed— Meat, 12 oz. Bread, 6 " Potatoes, 16 " Vegetables, 4 "
SUPPER.									
Tea, 1 pt. Bread,	Tea, 1 pt. Bread, 4 oz.	Tea, 1 pt. Bread, 4 oz.	Milk, 1 pt. Bread, 4 oz.	Tea, 1 pt. Bread, 5 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "	Tea, 1 pt. Bread, 6 oz. Butter, ½ "

NOTE.—Drinks for patients, on tea, spoon, and beef tea diets, are to be made and charged according to the following proportions:—

Barley-water.—Barley, 2 oz.; sugar, 2 oz. for every five pints.
Rice-water.—Rice, 2 oz.; sugar, 2 oz. for every five pints.
Lemonade.—One large lemon; and sugar, 1½ oz. to two pints.

DIET TABLE FOR GENERAL HOSPITALS, U. S. ARMY.

Articles composing the different Diets for a Day—Avoirdupois Weight.

FULL DIET.

Articles.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Fresh beef or mutton .... oz.	16	0	16	0	16	0	16
Bacon .... oz.	0	8	0	0	0	0	0
or							
Beef recently corned .... oz.	0	16	0	0	0	0	0
Pork .... oz.	0	0	0	8	0	0	0
Fish .... oz.	0	0	0	0	0	12	0
Bread .... oz.	16	16	16	16	16	16	16
Beans .... gill.	0	0	0	0·64	0	0	0
Potatoes .... oz.	8	10	8	10	8	10	10
Other vegetables .... oz.	4	4	4	4	4	4	4
Rice, hominy, or Indian meal ...... oz	1·60	1·60	1·60	1·60	1·60	1·60	1·60
Salt .... gill.	0·16	0·16	0·16	0·16	0·16	0·16	0·16
Coffee .... oz.	0·80	0·80	0·80	0·80	0·80	0·80	0·80
Tea .... oz.	0·12	0·12	0·12	0·12	0·12	0·12	0·12
Sugar .... oz.	2·20	2·20	2·20	2·20	2·20	2·20	2·20
Milk .... oz.	6	6	6	6	6	6	6
Butter .... oz.	1	0	1	0	1	1	0
Flour .... oz.	0·25	0·25	0·25	0·25	0·25	0·25	0·25
Molasses .... gill.	0·32	0·32	0·32	0·32	0·32	0·32	0·32
Vinegar .... gill.	0·16	0·16	0·16	0·16	0·16	0·16	0·16
Dried fruit .... oz	0	0	3	0	0	3	0
Pickles .... oz.	0	1	0	0	0	1	0

HALF DIET.

Fresh beef .... oz.	8
Bread .... oz.	16
Potatoes .... oz.	8
Other vegetables .... oz.	4
Rice, hominy, or Indian meal .. oz.	1·60
Salt .... gill.	0·16
Coffee .... oz.	0·80
Tea .... oz.	0·12
Sugar .... oz.	2·20
Milk .... oz.	6
Butter .... oz.	1
Flour .... oz.	0·25
Molasses .... gill.	0·32
Vinegar .... gill.	0·16
Friday.	
Codfish (in lieu of fresh beef) .... oz.	6

LOW DIET.

Meat .... oz.	8
Bread .... oz.	14
Salt .... gill.	0·16
Tea .... oz.	0·24
Sugar .... oz.	2·20
Milk .... oz.	6
Butter .... oz.	1
Rice, farina, corn starch, or bread, in pudding .... oz.	2

MILK DIET.

Bread .... oz.	16
Rice .... oz.	2
Milk .... pt.	3
Sugar .... oz.	1

Diet Table for General Hospitals, U. S. Army—Continued.

CHICKEN DIET.		BEEF-TEA DIET.	
Fowl...oz.	12	Beef, lean and without bone...oz.	8
Bread...oz.	16	Bread...oz.	12
Salt...gill.	0·16	Salt...gill.	0·32
Tea...oz.	0·24	Tea...oz.	0·24
Sugar...oz.	2·00	Sugar...oz.	2
Milk...oz.	6	Milk...oz.	6
Butter...oz.	1		

Extra Articles for Regular and Special Diets.

TO BE FURNISHED BY MEDICAL PURVEYORS.	TO BE PURCHASED WITH HOSPITAL FUND.
Barley.	Ale, draught.
Brandy.	Beef-steak.
Beef, extract.	Butter.
Cinnamon.	Cider.
Chocolate.	Corn meal.
Cocoa.	Crackers.
Corn starch.	Eggs.
Farina.	Fish.
Gelatine.	Fruit, fresh.
Ginger.	Fruit, dried.
Nutmegs.	Ham.
Pepper.	Ice.
Porter, bottled.	Lemons.
Sugar, white.	Milk.
Tapioca.	Mustard.
Tea, extra quality.	Mutton.
Whisky.	Mutton-chop.
Wine, sherry.	Oatmeal.
	Oysters.
	Oranges.
	Pepper.
	Pickles.
	Porter, draught.
	Poultry.
	Sugar, white.
	Vegetables.

Diet Table for General Hospitals, U. S. Army—Continued.

FULL DIET.

	Sunday.		Monday.	
Breakfast.	Coffee.............pt.	1	Coffee....................pt.	1
	Bread.............oz.	6	Bread....................oz.	6
	Butter.............oz.	1	Meat hash, with vegetables.................oz.	8
	Hominy, boiled...oz.	2		
	Molasses.........gill.	0·32		
Dinner.	Beef soup..........pt.	1	Beef, recently corned.....oz.	16
	Meat...............oz.	12	Or bacon, boiled..........oz.	8
	Bread..............oz.	4	Bread.....................oz.	4
	Potatoes...........oz.	8	Potatoes..................oz.	8
	Other vegetables..oz.	4	Cabbage, or other vegetables.................oz.	4
	Rice pudding.		Pickles...................oz.	1
Tea.	Tea................pt.	1	Tea.......................pt.	1
	Bread..............oz.	6	Bread.....................oz.	6
	Cold meat..........oz.	2	Molasses.................gill.	0·32

	Tuesday.		Wednesday.	
Breakfast.	Coffee.............pt.	1	Coffee....................pt.	1
	Bread.............oz.	6	Bread....................oz.	6
	Butter.............oz.	1	Meat hash, with vegetables.................oz.	8
	Rice, boiled........oz.	2		
	Molasses..........gill.	0·32		
Dinner.	Beef soup...........pt.	1	Pork, } baked or........oz.	6
	Beef soup meat...oz.	12	Beans, } in soup.......gill.	0·64
	Bread..............oz.	4	Bread.....................oz.	4
	Potatoes...........oz.	8	Potatoes..................oz.	8
	Other vegetables..oz.	4	Other vegetables..........oz.	4
			Indian pudding.	
Tea.	Tea................pt.	1	Tea.......................pt.	1
	Bread..............oz.	6	Bread.....................oz.	6
	Fruit, stewed......oz.	3	Molasses.................gill.	0·32

Diet Table for General Hospitals, U. S. Army—Continued.

FULL DIET—Continued.

	Thursday.		Friday.	
Breakfast.	Coffee..............pt.	1	Coffee.......................pt.	1
	Bread..............oz.	6	Bread.......................oz.	6
	Butter..............oz.	1	Butter.......................oz.	1
	Ind. meal, boiled..oz.	2	Fish, fresh or salt.......oz.	6
	Molasses.........gill.	0·32		
Dinner.	Semi-stewed beef or mutton.......oz.	12	Codfish hash, with potatoes...................oz.	16
	Do. do. soup...pt.	1	Bread.......................oz.	4
	Bread..............oz.	4	Beets, or other vegetables...................oz.	4
	Potatoes..........oz.	8	Pickles.....................oz.	1
	Other vegetables..oz.	4	Bread pudding.	
Tea.	Tea.................pt.	1	Tea.........................pt.	1
	Bread..............oz.	6	Bread.......................oz.	6
	Cold meat.........oz.	2	Fruit, stewed.............oz.	3

	Saturday.	
Breakfast.	Coffee....................pt.	1
	Bread....................oz.	6
	Meat hash, with vegetables....................oz.	8
Dinner.	Semi-stewed beef or mutton....................oz.	12
	Do. do. soup....................pt.	1
	Bread....................oz.	4
	Potatoes....................oz.	8
	Other vegetables....................oz.	4
Tea.	Tea....................pt.	1
	Bread....................oz.	6
	Molasses....................gill.	0·32

Diet Table for General Hospitals, U. S. Army—Continued.

HALF DIET.

	Sunday.		Monday.	
Breakfast.	Coffee...pt.	1	Coffee...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½
	Hominy, boiled...oz.	2		
	Molasses...gill.	0·32		
Dinner.	Beef soup...pt.	1	Beef soup...pt.	1
	Do. do. meat...oz.	8	Do. do. meat...oz.	8
	Bread...oz.	4	Bread...oz.	4
	Potatoes...oz.	8	Potatoes...oz.	8
	Other vegetables..oz.	4	Other vegetables...oz.	4
	Rice pudding.			
Tea.	Tea...pt.	1	Tea...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½

	Tuesday.		Wednesday.	
Breakfast.	Coffee...pt.	1	Coffee...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½
	Rice, boiled...oz.	2		
	Molasses...gill.	0·32		
Dinner.	Beef soup...pt.	1	Beef soup...pt.	1
	Do. do. meat...oz.	8	Do. do. meat...oz.	8
	Bread...oz.	4	Bread...oz.	4
	Potatoes...oz.	8	Potatoes...oz.	8
	Other vegetables..oz.	4	Other vegetables...oz.	4
			Indian pudding.	
Tea.	Tea...pt.	1	Tea...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½

Diet Table for General Hospitals, U. S. Army—Continued.

HALF DIET—Continued.

	Thursday.		Friday.	
Breakfast.	Coffee...pt.	1	Coffee...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½
	Ind. meal, boiled..oz.	2		
	Molasses...gill.	0·32		
Dinner.	Beef soup...pt.	1	Codfish hash, with potatoes...oz.	16
	Do. do. meat...oz.	8	Bread...oz.	4
	Bread...oz.	4	Vegetables...oz.	4
	Potatoes...oz.	8	Bread pudding.	
	Other vegetables..oz.	4		
Tea.	Tea...pt.	1	Tea...pt.	1
	Bread...oz.	6	Bread...oz.	6
	Butter...oz.	½	Butter...oz.	½

	Saturday.	
Breakfast.	Coffee...pt.	1
	Bread...oz.	6
	Butter...oz.	½
	Rice, boiled...oz.	2
	Molasses...gill.	0·32
Dinner.	Beef soup...pt.	1
	Do. do. meat...oz.	8
	Bread...oz.	4
	Potatoes...oz.	8
	Other vegetables...oz.	4
Tea.	Tea...pt.	1
	Bread...oz.	6
	Butter...oz.	½

Diet Table for General Hospitals, U. S. Army—Continued.

CHICKEN DIET.		LOW DIET.	
BREAKFAST.		BREAKFAST.	
Tea.......................pt.	1	Tea.......................pt.	1
Bread....................oz.	6	Bread....................oz.	5
Butter...................oz.	½	Butter...................oz.	½
DINNER.		DINNER.	
Chicken..................oz.	12	Beef tea, or mutton or chicken broth..........pt.	1
Or chicken soup..........pt.	1	Bread....................oz.	4
Bread....................oz.	4	Rice, farina, corn starch, or bread, in pudding.............oz.	2
TEA.		TEA.	
Tea.......................pt.	1	Tea.......................pt.	1
Bread....................oz.	6	Bread....................oz.	5
Butter...................oz.	½	Butter...................oz.	½

MILK DIET.		BEEF-TEA DIET.	
BREAKFAST.		BREAKFAST.	
Milk......................pt.	1	Tea.......................pt.	1
Bread....................oz.	6	Bread....................oz.	4
DINNER.		DINNER.	
Rice......................oz.	2	Beef tea.................oz.	12
Milk......................pt.	1	Bread....................oz.	4
Bread....................oz.	4		
Sugar....................oz.	1		
TEA.		TEA.	
Milk......................pt.	1	Tea.......................pt.	1
Bread....................oz.	6	Bread....................oz.	4

CHAPTER XXVIII.

CLOTHING.

Clothing is worn for the purpose of protecting the body from the effects of extreme heat or cold, and other meteorological influences, and from injuries. Among civilized nations other objects are had in view, but they are secondary, so far at least as their origin is concerned, to those specified.

The substances used by mankind for the fabrication of clothing are almost entirely derived from the vegetable and animal kingdoms of nature, very few of them being furnished from the mineral kingdom, and such as do thus originate admitting of but limited application. They consist of vegetable fibers or hairs of animals which are capable of being woven into textile fabrics, and skins, which are either, by the process of tanning, converted into leather, or are used after undergoing very little if any manipulation. In addition, there are certain grasses which admit of being manufactured into various articles of clothing, and silk, which is derived from the cocoon or covering of the chrysalis of the silk-worm.

Vegetable Substances.—The principal vegetable substances employed for clothing are *hemp*, *flax*, and *cotton*.

Hemp is not in extensive use as a clothing material. Its fibers are coarse and harsh unless great care is taken in its preparation and manufacture.

Flax is converted into fabrics which are called linen. Its applications for clothing purposes are numerous, and it possesses several advantages over other materials, espe-

cially for inside garments. It absorbs the perspiration from the body with great readiness, and consequently allows of its free evaporation. It is an excellent conductor of caloric, and hence is preferable for summer use to cotton, and is far more agreeable. For cold weather it is less suitable. It is a good conductor of electricity.

Cotton is more generally used as a substance for clothing than any other belonging to the vegetable kingdom. It is not so absorbent of moisture as linen, nor so good a conductor of heat. In cold weather, therefore, or when it is desirable to avoid the refrigeration which is produced by the evaporation of moisture from a material in contact with the body, cotton is to be preferred for inner clothing to any other material.

In addition to the substances mentioned, certain grasses are used for the production of fabrics which are employed mainly in the manufacture of coverings for the head, and caoutchouc, which is converted into several useful articles of clothing. The latter is entirely impervious to moisture, and is a bad conductor of heat. Although, therefore, it serves effectually to protect the body from atmospheric humidity, it is calculated, if garments constructed of it are worn for any length of time, to produce discomfort and even disease.

ANIMAL SUBSTANCES.—*Wool* is the principal substance in use, as a material for clothing, belonging to this class. It is obtained from many animals, but mainly from the sheep. Woolen fabrics are bad conductors of heat, and do not readily absorb moisture. Moreover, owing to their thickness and porosity they entrap small particles of air in their interstices, and are thus rendered more capable of retaining the warmth of the body. Wool is principally used for outer clothing, but it should be worn next the skin in cold or changeable weather.

Furs, which consist of the skins of animals with the hair

attached, are very warm, and are used as means of protection against extreme cold.

The *skins* of animals when subjected to the tanning process become converted into *leather*, and are then chiefly employed, so far as the purposes of clothing are concerned, in the manufacture of coverings for the feet. Skins, when dressed and deprived of their hair, are also useful materials in making certain articles of wearing apparel.

Silk is a good non-conductor of heat, and does not readily absorb moisture. It is also a non-conductor of electricity, and is on this account useful in certain cases as a clothing material.

INHERENT QUALITIES OF CLOTHING.—There are several considerations relative to clothing which are worthy of attention, as influencing very much our selections according to the objects we may have in view. It should be light, and at the same time capable of retaining the heat of the body in winter, while, as far as possible, excluding the heat of the sun or of the atmosphere in summer. It should also be of such a character as will allow of the free passage of the exhalations from the skin, and yet not readily absorbent of moisture from the outside. Excessive weight in clothing is very objectionable, as tending to produce fatigue and discomfort. Imperviousness, except during inclement weather for a limited period, is still worse, and may, by retaining the cutaneous excretions in contact with the body, lead to serious disease.

As *affording protection against cold*, the experiments of Coulier* furnish us valuable knowledge relative to the influence exerted by various fabrics. A cylindrical vessel of thin brass was suspended so as not to be subject to cur-

* Expériences sur les Étoffes que Servent a Confectionner les Vétements Militaires. Journal de la Physiologie de l'Homme et des Animaux, 1858, tome i. p. 122.

rents of air. Different fabrics were in turn placed around it, the vessel being filled with water at 50° centigrade, (122° Fahrenheit,) and closed with a cork, through which a sensitive thermometer passed into the water. It was then noted how long a time was required for the temperature to fall to 40° centigrade, (104° Fahrenheit.) The following table shows the results:—

Kind of fabric.	Time required for cooling.	
Vessel uncovered	18 min.	12 sec.
Cotton cloth for shirts	11 "	30 "
Cotton cloth for linings	11 "	15 "
Hemp cloth for linings	11 "	25 "
Dark-blue woolen cloth for soldiers' uniforms	14 "	45 "
Red woolen cloth for soldiers' uniforms	14 "	50 "
Blue cloth for soldiers' great-coats	15 "	5 "

From these observations it is seen that the uncovered vessel cooled more slowly than when inclosed in any material, and that thin cotton cloth is a better conductor of heat, and heavy, blue woolen cloth a worse conductor, than the other fabrics used in the experiments.

My own observations tend to the same general conclusions as those of Coulier. I took a cylindrical brass vessel, of 100 cubic inches capacity, and fitted to it a cork, through which a delicate thermometer passed in the same manner as did Coulier in his experiments. The textile articles used in the investigations were made into cylindrical bags, which fitted accurately around the vessel. The latter was filled with water at 150° Fahrenheit, and the time noted which elapsed till it had cooled to 140° Fahrenheit. The results are exhibited in the accompanying table:—

Kind of fabric used.	Time required for cooling.	
Vessel uncovered	15 min.	11 sec.
Cotton shirting	9 "	42 "
Linen shirting	7 "	24 "
White flannel	12 "	35 "
Dark-blue woolen cloth	14 "	05 "
Light-blue woolen cloth	13 "	50 "

The cotton flannel and woolen cloths were samples of the fabrics used in the manufacture of the shirts, coats, and trowsers of the United States troops. As in Coulier's experiments, it is seen that the uncovered brass vessel cooled less rapidly than when surrounded with any other substance. This was due to the well-known fact that all the polished metals are bad radiators of heat. The general results are, however, not affected by this circumstance, and the superiority of woolen clothing over that of linen or cotton, as affording protection against cold by retaining the heat of the body, would, if we did not already know it by long personal experience, be sufficiently established by the experiments cited.

As protecting agents against the effects of *extreme heat*, there are also great differences to be observed between the several substances used for clothing. Coulier, in the memoir referred to, gives the results of his experiments in this direction. He took a glass tube and divided it into pieces, each about three inches long. One end was hermetically closed, and the tubes covered with the several fabrics to be experimented with. A like quantity of mercury was next placed in each tube, and they were exposed to the atmosphere in the shade, a delicate thermometer serving to indicate the temperature. So little variation was perceived that it was not worth being taken into practical consideration; but when they were placed in the sun,

the results obtained were much more striking, as will be seen from the following table. The degrees of temperature are according to the centigrade scale.

Substances used.	Temperature of tubes.	Difference with the temperature of the uncovered tube.
Thermometer in the shade	27°	
Thermometer exposed to the sun	36°	
Uncovered tube	37·5°	
Cotton cloth for shirts	35·1°	— 2·4°
Cotton cloth for linings	35·5°	— 2°
Unbleached hemp cloth	39·6°	+ 2·1°
Dark-blue woolen cloth for soldiers' uniforms	42°	+ 4·5°
Red woolen cloth for soldiers' uniforms	42°	+ 4·5°
Bluish-gray woolen cloth for soldiers' uniforms	42·5°	+ 5°
Red cloth for non-commissioned officers' uniforms	41·4°	+ 3·9°
Dark-blue cloth for non-commissioned officers' uniforms	43°	+ 5·5°

The mercury in the uncovered tube giving 37·5°, it is clear that the variation of temperature above or below this point was due to the action of the fabric interposed between the tube and the direct rays of the sun. It was further found that if cotton was superposed on cloth, its effect was to present as great a rise of temperature as took place when the cloth alone covered the tube.

I have several times repeated Coulier's experiments relative to these points, and am satisfied of their accuracy. As he remarks, the experiments relative to fabrics considered as means of protection against the heat of the direct rays of the sun, are worthy of the attention of the military surgeon. It is very evident that a white cotton overall or duster would be a very efficacious protection against the solar rays, for, as he has shown, a thin cotton tissue, worn over a cloth coat, is sufficient to reduce the temperature 7°, (12·6° Fahrenheit.) In the warm seasons in our own climate, especially in the southern parts of the country, it would be in the highest degree advisable to act

upon the knowledge which M. Coulier's observations have afforded us.

Relative to the *capacity for moisture* possessed by different stuffs, experiments are not wanting. Coulier has also investigated this point, and has given us some interesting results.

The water which he finds a fabric capable of absorbing he divides into two portions, that which, though absorbed in considerable quantity, is not appreciable either by the vision or the touch, but only by the balance or the lengthening which takes place in the fibers. This he calls hygrometric water. The other he designates water of interposition. This changes the whole character of the fabric; the hand applied to it experiences the sensation of moisture, and it is possible to squeeze from it a certain quantity of water, which can never be expelled from a fabric charged to saturation with hygrometric water.

"When a stuff is exposed in an atmosphere saturated with the vapor of water, it becomes saturated with hygrometric water. The quantity of water absorbed is constant. To appreciate it I have first suspended pieces of the several fabrics, two decimetres square, (about six inches,) in bell-glasses placed over quick-lime. After twenty-four hours, the desiccation was considered as complete. The pieces were then immediately weighed with care, and suspended in bell-glasses placed over water. The absorption of hygrometric water is very rapid at first, but toward the end becomes slower. I weighed the stuffs after they had remained twenty-four hours over the water, and obtained the results which are given in the following table.

"The squares of fabrics thus used were subsequently soaked for twenty-four hours in distilled water, and then suspended by one corner in a bell-glass placed over water, the lower angle being furnished with a thread to allow of the more ready drainage of the water from the stuff. After

remaining twenty-four hours in the bell-glasses, the fabrics were weighed. It is easy to see that by subtracting from the weight obtained the weight of the stuff and of the hygrometric water, the weight of the water of interposition is found."

The following is the table of results obtained by M. Coulier. The figures refer to grammes.

Fabric subjected to experiment.	Weight after 24 hours suspension over lime.	Weight after 24 hours suspension over water.	Weight after 24 hours suspension and 24 hours immersion in water.	Hygrometric water.	Water of interposition.	Hygrometric water for one gramme of stuff.	Water of interposition for one gramme of stuff.
Cotton cloth for shirts	7·55	8·50	14·40	0·95	5·90	0·126	0·781
Cotton cloth for linings	7·75	8·40	15·40	0·65	7·00	0·084	0·908
Linen cloth for linings	11·19	12·90	19·40	1·71	6·50	0·153	0·580
Dark-blue woolen cloth for soldiers' uniforms	19·75	23·12	51·40	3·37	28·28	0·171	1·432
Red woolen cloth for soldiers' uniforms	19·58	23·28	55·40	3·70	32·12	0·188	1·064
Bluish-gray woolen cloth for overcoats	20·80	24·15	52·30	3·35	28·15	0·161	1·402
Red woolen cloth for non-commissioned officers' uniforms	19·52	22·85	54·20	3·33	31·35	0·171	1·600
Dark-blue woolen cloth for non-commissioned officers' uniforms	17·65	20·20	47·30	2·55	27·10	0·200	1·540
Fine hemp cloth for shirts	9·67	11·00	15·75	1·33	4·75	0·142	0·490

From this table it is seen that cotton does not rank high as an absorbent substance, and that wool is pre-eminent in this respect; hemp and linen occupying an intermediate place. These experiments relate to the quantity of water which the fabrics in question are capable of absorbing when full time is allowed for saturation. When, however, we extend the inquiry so as to comprehend the subject of the comparative rapidity of absorption, we find the relation somewhat changed. From some experiments which I made a short time since I found that pieces of cotton,

linen, hemp, and woolen cloths, three inches square, on being immersed in water became saturated in the following order: linen, hemp, cotton, wool. Every one must have noticed how much more readily linen and hemp become wet than cotton or wool, and it is on this account that the former is so much cooler in hot weather when worn next the skin than any other fabric, as it absorbs the perspiration more readily and gives it off by evaporation, whereby the temperature of the body is reduced. For affording protection against rain, woolen cloth is preferable to either of the other substances named, as it does not readily become wet.

The *color* of clothing is also an important point to be considered, and here we find that much has been accomplished toward the extension of our knowledge. In 1792 Count Rumford instituted a series of experiments relative to the influence of color over the amount of solar heat absorbed in a given time. He found that, *cæteris paribus*, black was pre-eminent as causing the absorption of more heat than any other color.

Franklin next investigated the subject, and with his accustomed accuracy. He exposed different colored cloths, placed on snow, to the direct heat of the sun, and observed the different relative depths to which they sank. Those which sank lowest were of course those which had absorbed the greatest amount of heat. From his experiments, Franklin came to the conclusion "that black clothes are not so fit to wear in a hot, sunny climate as white ones, because in such clothes the body is more heated by the sun when we walk abroad, and are at the same time heated by the exercise, which double heat is apt to bring on putrid, dangerous fevers." He therefore thinks that soldiers and sailors, in tropical climates, should wear white uniforms, and that white hats should be generally worn in summer.

In 1799 Sir Humphrey Davy performed his experiments,

which consisted in exposing pieces of copper, differently colored, and on the under surface of which cerate was spread, to the heat of the sun. His results were entirely confirmatory of those arrived at by Franklin.

In 1833 Stark instituted his investigations, the results of which are published in the *Philosophical Transactions* for that year. His conclusions are almost identical with those previously arrived at by Franklin and Davy, as is seen from the following table, in which the several colors experimented with are arranged in the order of their absorptive power for heat as determined by the observers referred to:

		Stark.	
Franklin.	Davy.	Colored wool.	Colored bulb of thermometer.
Black.	Black.	Black.	Black.
Deep blue.	Blue.	———	Dark blue.
Light blue.	———	———	Brown.
Green.	Green.	Dark green.	Green.
Purple.	———	———	———
Red.	Red.	Scarlet.	Orange red.
Yellow.	Yellow.	———	Yellow.
White.	White.	White.	White.

In the *Journal of the Franklin Institute* for November, 1833, Prof. A. D. Bache gives the details of a series of experiments which he instituted relative to the absorptive power of substances for heat as modified by color. Prof. Bache concluded that the color of a substance is only of influence in regard to luminous heat, and that if a person keeps in the shade it makes no difference what is the color of his clothing. As the heat given off from the body is non-luminous, it follows that the loss of heat by the body is not influenced by the color of the clothing. A fact which Coulier (who evidently was unaware of Prof. Bache's experiments) also established.

I have several times repeated Franklin's and Bache's

experiments, and have always obtained results entirely confirmatory of theirs. I took a cylinder of brass closed at one end, and filled it with sand. Different colored cloths were wrapped around it, and a delicate thermometer placed in it. The apparatus was then exposed to the direct rays of the sun, and I noticed how long a time was required to raise the mercury from 60° to 80° Fahrenheit. The action of non-luminous heat was ascertained by exposing the arrangement to the heat emitted from a gas-burner surrounded by a copper cylinder.

From the facts adduced it will be seen how important is the influence exerted by cold over the power of a substance to absorb heat, and how correct is the instinct which guides us to the choice of white and light-colored garments for summer wear, and black and dark-colored clothing for winter use.

Color likewise affects the power of a substance to absorb moisture. Stark, in the paper already referred to, also states the results of his experiments in regard to this point. On a foggy night he exposed 30 grains of black wool, 30 of scarlet wool, and the same quantity of white wool, to the action of the atmosphere. When weighed in the morning the black wool had gained 32 grains, the scarlet wool 25 grains, and the white wool 20 grains, deposited as frost. A few days afterward, when there was less moisture in the atmosphere, he repeated the experiment, using 10 grains of each. When the wool was weighed, the black had gained 10 grains, the scarlet 9·5 grains, and the white 5 grains.

Another point relative to the influence of color, and which may properly claim notice in a work on hygiene, is the relative frequency with which soldiers with different colored clothing are struck by bullets in battle. It is found that red is the most fatal color that can be made, the proportion being red 12, green 7, brown 6, and bluish-gray 5.

Cloth of the color now worn by the line of the army for trowsers would be an admirable color for the whole uniform of our soldiers.

CHAPTER XXIX.

THE HYGIENIC RELATIONS OF CLOTHING WITH THE SEVERAL PARTS OF THE BODY.

THE HEAD.—The covering for the head should be light, should afford protection against inclement weather, and should be capable of warding off the effects of the direct rays of the sun. It should shade the eyes and face, and at the same time protect the neck from wet and heat.

Perhaps no article of clothing is so imperfect as the hat. Though some forms are better than others, none, either those for males or females, can be regarded as fulfilling all the indications required, so that it may be questioned whether it would not be better, in a sanitary point of view, to wear no covering for the head, than to use the uncomfortable and unhealthy patterns which are in vogue. Nothing can be more misplaced than the tight-fitting dress-hat ordinarily worn. Made of substances which are almost complete non-conductors of caloric, they retain the heated air in contact with the head, and thus give rise to diseases of the scalp, and even to affections of the brain. The low-crowned and broad-brimmed felt hat is better, and answers tolerably well in winter weather. Straw, or the other vegetable substances used for the purpose, are the best of all materials for hats for summer use, and for winter, woolen cloth.

For soldiers, the forage-cap now in use in the army, with

a water-proof cover for inclement weather, is preferable to any other form of head-covering. It is light, and the visor affords sufficient shade for the eyes. The felt hat is heavy, and has no advantages, either hygienically or æsthetically, over the *kepi*. The head-dress of the zouaves is well adapted to keep off the direct heat of the sun from the head, but does not afford sufficient ventilation, and is objectionable on other accounts. It is asserted by M. V. Wiaal* that ophthalmia is much more frequent among the zouaves and *tirailleurs* serving in Algiers, who wear no visors to their turbans, than the *chasseurs d'Afrique* and engineer soldiers, who wear a cap with a large visor. The helmets of metal and leather formerly worn by soldiers were execrable, from their weight and imperviousness; and the shakos and bearskin caps, now in use in several European armies, are no better.

THE NECK.—As a rule, the neck should be left bare. The custom of constricting it by tight-fitting collars and cravats is exceedingly objectionable, as preventing the free circulation of the blood in its passage to and from the head. Moreover, by ordinarily keeping the neck wrapped up, the liability to take cold is very much increased when the covering is from any cause dispensed with. This is especially the case with children, in whom the neck should always be left exposed to the air, except in the coldest weather, when a temporary covering may be used.

Soldiers have for over two hundred years endured the tortures of leathern stocks and tight-fitting cravats. That apoplexy, cerebral congestions, epilepsy, hemorrhages, vertigo, and other affections have been produced by this most pernicious practice, there can be no doubt. Fortunately for

* De l'Influence des Coiffures Militaires sur le Développement de l'Ophthalmie Purulente, etc. Recueil de Mémoires de Médecine, de Chirurgie, et de Pharmacie Militaires. 2ème serie, tome xvii. 1856, p. 211.

humanity, the stock and tight cravat are long abolished in many armies. The leather stock is still, however, used in the United States army, but it is low, and is not generally worn very tight. It would be well if it were altogether abolished, and that the principle was recognized of leaving the neck uncovered and the head free to turn, as occasion might require. If a cravat is worn, it should be of some soft material, and should not be so high as to prevent the free motion of the head. A loose silk ribbon can scarcely be considered hurtful, so long as fashion requires some kind of cravat to be worn.

TRUNK AND LIMBS.—The covering of the trunk and limbs is of especial importance, on account of the large extent of surface which these parts of the body possess. It is therefore necessary to guard against atmospheric vicissitudes with more care than requires to be exercised with other regions.

With reference to the propriety of wearing woolen clothing next to the skin no doubt can exist, especially in regard to those who are exposed to sudden and extreme alternations of temperature. But in order that all objection to it should be obviated, the utmost cleanliness is necessary. The inside clothing should be frequently changed and the body well washed, as woolen cloths retain more effectually than other fabrics the exhalations which are given off from the skin. The clothing used for these parts of the body should vary in character according to the season, and the principles which have been stated in the preceding chapter should be brought into application. In the military service it would be especially desirable that a thin white cotton or linen jacket or tunic were issued for summer use, together with trowsers of the same color and material.

It is important that the motions of the chest, abdomen, and limbs should not be restricted by the clothing. Hence tight waistcoats, corsets, stays, coats, and trowsers are highly

injurious. This is particularly to be guarded against in children, in whom the bones are soft and easily bent out of their proper shape.

Overcoats should always be worn when the weather is cold enough to require them, but the use of India-rubber or other water-proof garments is not to be commended. The remarks of Lévy* on this subject are very apposite.

"Cloaks or overalls of impermeable fabrics concentrate the heat, and condense on their internal surface the vapor of the cutaneous transpiration, which cannot pass through them. It is necessary to have worn, during a day's journey or a night in a carriage, one of these garments—which are so much used on account of their lightness, their cheapness, and the facility with which they can be rolled into a small compass—to appreciate how uncomfortable and unhealthy they are. They place an individual in motion in the condition of a wet stove—the more they accumulate heat around him, the more they expose him to be chilled. A person wrapped in them during a rain, when the humidity of the atmosphere is at its maximum, is steamed with sweat, which accumulates under the impermeable garment, while the moisture of the air steams from the external surface. It is better not to attempt to isolate the individual from atmospheric influences, but to graduate and moderate the changes which are in action between him and the medium, whatever it may be, in which he lives. The Council of Health of the army, though twice consulted relative to the introduction of impermeable garments into the service, has persistently and with wisdom refused to recommend them."

EXTREMITIES.—The proper covering of the hands and feet cannot receive too much attention, not only because such protection is necessary to maintain these organs in a condi-

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* Traité de Hygiène, tome ii. 4ème edition, 1862, p. 244.

tion to be most useful to us, but also because if they are subjected to sudden or extreme refrigeration, disease is liable to be set up in some distant and important part of the body. This is more particularly the case with the feet than with the hands.

Gloves are made of different materials, according to the main object to be attained in wearing them. When worn to protect the hands from the heat of the sun, from dust and dirt, and to keep the skin soft, pliable, and white, kid, silk, linen, or cotton is used. The delicacy of touch so necessary in many professions, can only be preserved by giving attention to the protection of the hands from the influences mentioned.

Gloves to keep the hands warm should be of wool or fur. Buckskin or other similar material may also be used.

Boots and shoes are made of various substances, leather being more generally used in their manufacture than any other material. Individuals experience a great deal of discomfort from wearing tight or otherwise ill-fitting shoes or boots. The movements necessary in walking cannot, under such circumstances, be performed without pain, and the consequence is that, if they continue in operation, deformities and diseases of the feet are produced. The proper shape to be given to the boot or shoe is therefore a matter of very great importance, above all to those whose occupations require them to walk or be on their feet the greater part of the day. But it is a subject which is almost entirely disregarded until, by painful experience, we find the results of our neglect exhibited in our own persons.

The principal points to be attended to in obtaining a properly made shoe are, that the sole shall be as broad as the foot when the weight of the body rests upon it; that it is long enough to allow of the full play of the foot in walking; and that the uppers shall be made of a soft, pliable substance, or have an elastic material united with it in

such a manner as to allow the necessary yielding to take place.

With reference to the breadth of the sole, it would appear scarcely necessary to say much, for it is a self-evident proposition that deformity of the foot will inevitably result if it is squeezed into a receptacle too narrow for it, and that walking can never be comfortably performed in shoes thus constructed. But it is a fact, that not one pair of shoes in a hundred that are worn have soles as wide as the soles of the feet. The consequence is, that a projection of the upper leather takes place, and that width is thus obtained at the cost of much pain and annoyance. Before the foot is able to force the leather into this position much mischief is done. Corns and bunions are formed from this cause, and from no other.

The length of the shoe is equally as important. It is usual for shoemakers to measure the length of the foot while it is in repose, not knowing, as does every anatomist, that in walking the foot undergoes considerable elongation. Dr. Camper and Mr. Dowie,* the latter a very intelligent shoemaker, have pointed out this fact, and it would be well if shoemakers generally followed their precepts. The elongation which takes place is fully half an inch, and, in consequence of no provision being made for this lengthening, callosities and ingrowing toe-nails are produced.

Hard and unyielding upper leathers are calculated to constrict the feet, and to prevent the proper motions of these organs being performed. Elastic gussets inserted into the shoes obviate this difficulty, and well-tanned calfskin is sufficiently soft and yielding to answer the purpose.

The shoes of soldiers should always be selected with great care, and should be made according to the principles

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* The Foot and its Coverings, by James Dowie. London, 1861, pp. 14 and 96.

laid down. Especially is it important that sufficient breadth should be given to the sole, and that it should not taper too much toward the point. The heels should be low and broad, so as to afford a firm support. High heels cause the foot to be pushed down toward the points of the shoes, and tend to produce flattening of the arch.

India-rubber shoes should never be worn, unless temporarily, to avoid wetting the feet. Great harm is done by persons wearing such shoes for hours at a time, during which period none of the cutaneous exhalation can escape. The consequence is that the feet are kept bathed in moisture.

Gaiters are a great protection to the ankles and instep when low shoes are worn, and may be made capable of affording much support to the muscles of the leg, besides preventing varicose veins. They may be made of woolen or linen cloth or of leather.

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THE END.